Table of contents

Instruction: W0010031
-TPNO: 0 001 36. ..

Continue: A01

Table of contents

Continue: IV25/1

SPECIAL FEATURES

These instructions describe repair operations on the following preengaged-drive starting motors of type IF

- 12 V/1.9 kW	0 001 366 ...
- 12 V/2.2 kW	0 001 362 ...
- 12 V/2.3 kW	0 001 362 ...
- 12 V/2.7 kW	0 001 362 ...
- 12 V/3.0 kW	0 001 367 ...
- 12 V/3.1 kW	0 001 369 ...
- 12 V/3.6 kW	0 001 369 200

Continue: I02/2

SPECIAL FEATURES

- 24 V/2.6 kW	0 001 363 ...
- 24 V/3.2 kW	0 001 363 ...
- 24 V/4.0 kW	0 001 368 ...
- 24 V/4.8 kW	0 001 364 300
- 24 V/5.2 kW	0 001 364 ...

Continue: I03/1

SPECIAL FEATURES

The drive-end bearing is either made of grey cast iron (closed design) or die-cast aluminum (open design). Disassembly and assembly of the two versions are described separately. The intermediate bearing is either made of cast iron or sheet steel. A damaged bushing can be replaced if the intermediate bearing is made of cast iron. This is not possible with the sheet-steel type. In this case the entire intermediate bearing has to be replaced.

Continue: I03/2

SPECIAL FEATURES

The overrunning-clutch drive is subject to considerable wear and is always to be replaced.
It is no longer possible to replace the bushing in the overrunning-clutch drive. This applies to both overrunning clutch drives with a sintered-metal bushing and to those with a Vandervell bushing.

The carbon brushes and helical compression springs are likewise always to be replaced.

Continue: I04/1

SPECIAL FEATURES

As far as the solenoid switch is concerned, there is no means of testing which provides reliable information on trouble-free operation over a lengthy period.
It is therefore advisable to renew the solenoid switch as well when repairing the starting motor.

The fitting mandrel, which has to be made for installing the excitation winding, should be hardened and ground so as not to damage the pole shoes.

Continue: I04/2

SPECIAL FEATURES

IF starting motors with rubber bellows or rubber ring for sealing the solenoid switch may be subject to failure caused by water penetration at the fastening screws of the solenoid switch.

For this reason, approx. 0.5 g of Loctite 577 (5 994 090 000) is to be applied to the threads of the fastening screws (countersunk screws) on solenoid-switch replacement.

Continue: I05/1

SPECIAL FEATURES

In the event of partial starting-motor repair, the carbon brushes and brush holder may not have to be checked or replaced.
In such cases, the special tool 0 986 617 122 (KDAL 5035) can be used to center the brush holder and fix the carbon brushes.
This makes starting-motor assembly much easier.

Continue: I01/1

PC user prompting:
Position cursor on button and confirm.
Microcard user prompting:
User prompting is provided on every page e.g.:
- Continue: I 17/1
- Continue: II 18/1 Fig.: II 17/2

Brief instructions may include several rows of coordinates.
I../. = first coordinate row
II../. = second coordinate row
III../. = third coordinate row
etc.

.../1 = upper coordinate half
.../2 = lower coordinate half

Continue: I01/1

GENERAL

Unless otherwise stated, the voltages indicated in these instructions are DC voltages.
AC voltages are marked by the symbol " * ".

Continue: I07/2

GENERAL

Expert repairs are only possible using the prescribed tools and measuring instruments, which are in perfect working order. We therefore recommend that exclusive use be made of the tools listed.

The use of incorrect and unsuitable tools and testers can lead to injury and may damage the product concerned or its component parts.

Continue: I08/1

GENERAL

Only use replacement parts given in the service parts list for the starting motor concerned.

Proper functioning presupposes use of the lubricants specified in these instructions, both prior to and during assembly.

Absolute cleanliness is to be ensured when performing repair work.

Continue: I01/1

SAFETY MEASURES

Component cleaning:
Armatures, excitation windings, commutator end shields, relays and overrunning-clutch drives are only to be cleaned using compressed air (max. 4 bar) and a clean rag. Liquid cleaning agents are never to be employed.

Other parts such as intermediate bearings and drive-end bearings can be washed out in a commercially-available cleaning agent, provided that it is not readily flammable. Take care to avoid inhalation of vapors! Bushings must be re-lubricated and pocket-type bushings regreased.

Continue: I09/2

SAFETY MEASURES

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Always use the listed tools. Injuries cannot be precluded if use is made of incorrect and unsuitable tools and testers.

Continue: I10/1

SAFETY MEASURES

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: I10/2

SAFETY MEASURES

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTERS, FIXTURES, TOOLS

The following list contains all tools needed for repairing type IF starting motors.

Some of the tools required have to be made on the basis of the drawings provided.

In the case of tools which used to have to be ordered by quoting their type designation, the designation is indicated in parentheses.

Continue: I11/2

TESTERS, FIXTURES, TOOLS

Interturn short-circuit tester with test probes:	0 986 619 110
Test prods:	0 986 619 101
(Old version:	0 986 619 114)
Alternator tester WPG 012.00:	0 684 201 200
(alternatively, Motortester)	
Magnetic measurement stand:	4 851 601 124
Dial indicator:	1 687 233 011
Mandrel press:	comm. avail.

Continue: I12/1

TESTERS, FIXTURES, TOOLS

Clamping support:	0 986 619 362 (KDAW 9999)
Torque wrench (0...70 Nm):	comm. avail.
Torquemeter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
Stay bolt fitting and extraction tool:	comm. avail.

Continue: I12/2

TESTERS, FIXTURES, TOOLS

Spring balance (2...12 N):	0 986 619 181 (KDAW 9991)
Pole-shoe screwdriver:	0 986 619 393 (KDAW 9999/7)
Torx T50 bit with 5/16" hexagon:	comm. avail.
Torx T40 bit with 1/4" hexagon:	comm. avail.
Torx T25 bit with 1/4" hexagon:	comm. avail.

Continue: I13/1

TESTERS, FIXTURES, TOOLS

Bushing puller:	0 986 617 243 (KDAL 5493)
Spring collet for bushing diameter 12.5 mm:	0 986 617 246 (KDAL 5493/0/3)
Spring collet for bushing diameter 14.3 mm:	0 986 617 251 (KDAL 5493/0/8)

Continue: I13/2

TESTERS, FIXTURES, TOOLS

Fitting mandrel with plate washer for bushing diameter 12.5 mm:	0 986 617 212 (KDAL 5486)
Carbon-brush assembly tool. Depending on type:	0 986 617 115 (KDAL 5030)
	0 986 617 116 (KDAL 5031)
	0 986 617 117 (KDAL 5032)

Continue: I14/1

TESTERS, FIXTURES, TOOLS

Fitting sleeve for snap ring
for armature shaft
diameter 14.2 mm: 0 986 617 114
(KDAL 5029)

Snap-ring pliers: comm. avail.

Flat-nosed pliers: comm. avail.

Gripping pliers: comm. avail.

Continue: I14/2

TESTERS, FIXTURES, TOOLS

Tailstock rest with
Morse taper 2 for chucking
diameter 5...45 mm
for holding armature
when turning down: 0 986 619 156
(KDAW 9987)

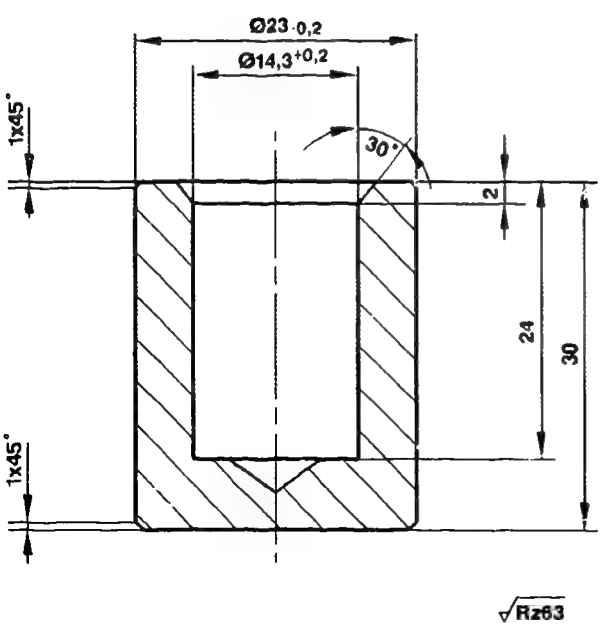
Fitting mandrel
diameter: 75,80...75,85 mm
(own make)

Continue: I15/1

Centering sleeve for
brush holder: Own make

Continue: I16/1 Fig.: I15/2

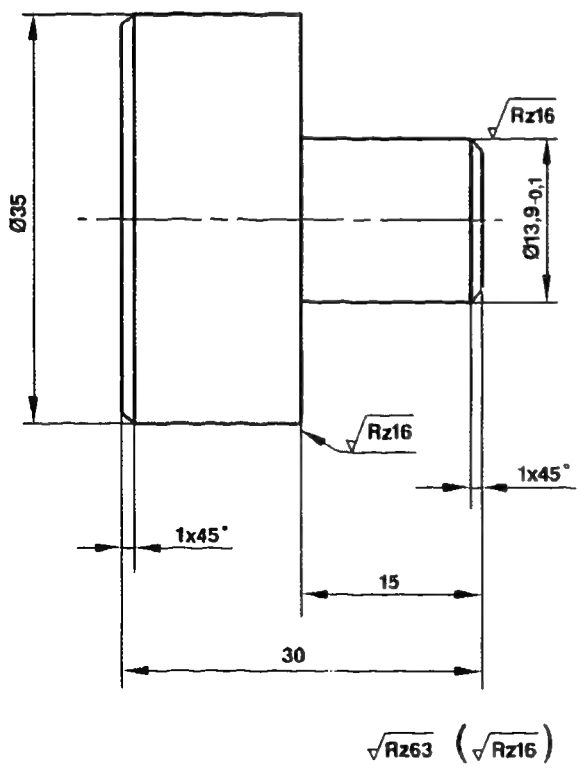
KMS00244



Fitting mandrel for bushing diameter 14.3 mm in commutator end shield: Own make

Continue: I17/1 Fig.: I16/2

KMS00243

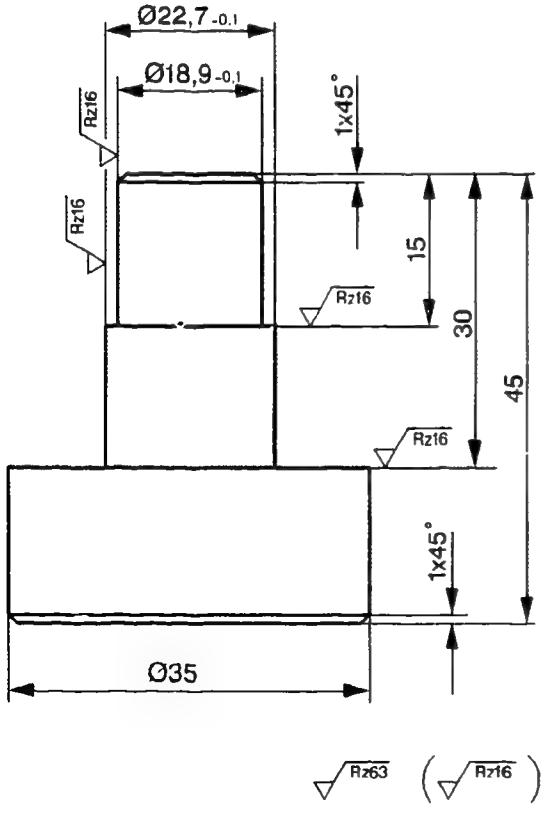


$\sqrt{Rz63}$ $(\sqrt{Rz16})$

Extraction mandrel for bushing diameter 18.9 mm in intermediate bearing: Own make

Continue: I18/1 Fig.: I17/2

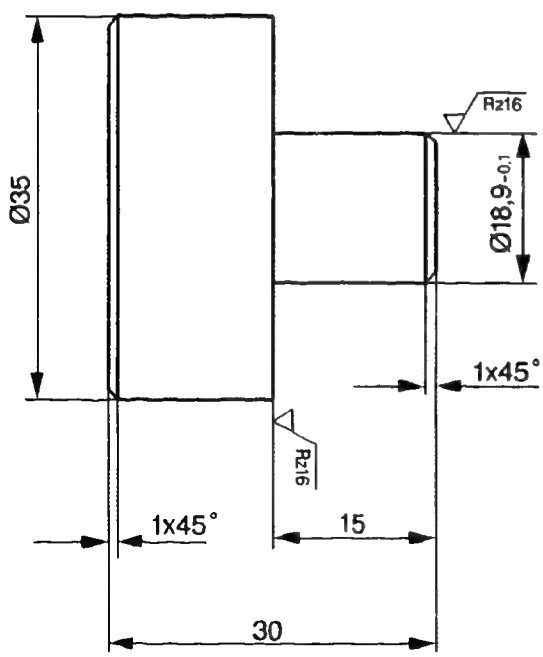
KMS00245



Fitting mandrel for bushing diameter 18.9 mm in intermediate bearing: Own make

Continue: I01/1 Fig.: I18/2

KMS00246



Rz63 (Rz16)

TEST SPECIFICATIONS AND SETTINGS

Commutator - minimum diameter:	42,5 mm
Radial run-out - Commutator:	< 0,03 mm
Armat. axial clearance:	0,1...0,6 mm

Continue: I19/2

TEST SPECIFICATIONS AND SETTINGS

Total pinion travel a:	13...17 mm
(depending on version)	16...20 mm

Armature braking torque

Type IF 0 001 362 ...:	0,45...0,75 Nm
Type IF 0 001 363 ...:	0,45...0,75 Nm
Type IF 0 001 366 ...:	0,45...0,75 Nm
Type IF 0 001 364 ...:	0,50...1,20 Nm
Type IF 0 001 367 ...:	0,50...1,20 Nm
Type IF 0 001 368 ...:	0,50...1,20 Nm
Type IF 0 001 369 ...:	0,50...1,20 Nm

Continue: I20/1

TEST SPECIFICATIONS AND SETTINGS

Resistances of solenoid switch

Solenoid-switch pull-in voltage	
12 V starting motor:	5... 8 V
24 V starting motor:	15...18 V
Pull-in winding	
-12 V starting motor:	0,23...0,25 Ohm
Pull-in winding	
-24 V starting motor	
Type IF 0 001 363...:	1,51...1,65 Ohm
Type IF 0 001 368...:	1,27...1,39 Ohm
Type IF 0 001 364...:	1,05...1,11 Ohm

Continue: I20/2

TEST SPECIFICATIONS AND SETTINGS

Resistances of solenoid switch

Holding winding	
-12V- Starting motor	1,00...1,10 Ohm
Holding winding	
-24V- Starting motor	
Type IF 0 001 363...:	4,40...4,80 Ohm
Type IF 0 001 368...:	4,14...4,64 Ohm
Type IF 0 001 364...:	3,34...3,52 Ohm

Continue: I01/1

TIGHTENING TORQUES

Attachment of bearing-end plate to commutator end shield:	4,5...6,0 Nm
Commutator end-shield attachment:	9,1...12,2 Nm
Relay attachment:	4,5...6,0 Nm
Bearing pin of engaging lever in drive-end bearing (hexagon nut):	9,0...11,0 Nm
Pole-shoe bolts:	40...53 Nm
Connection, excitation winding tm. 30/30-f (M10 steel):	12...15 Nm
Connection, excitation winding tm. 30/30-f(M10 copper):	10...12 Nm

Continue: I01/1

LUBRICANTS/LUBRICATION CHART

General:
Commutator and carbon brushes are to be kept free of grease and oil.

Greased parts are to be degreased prior to re-lubrication.

Slightly lubricate bright parts (bolts, nuts, fits, etc.).
Oil 41 v 2: 5 701 351 000

New bushings must be immersed in oil for approx. 1 hour before fitting.
Oil VS 13 834-01: 5 962 260 000

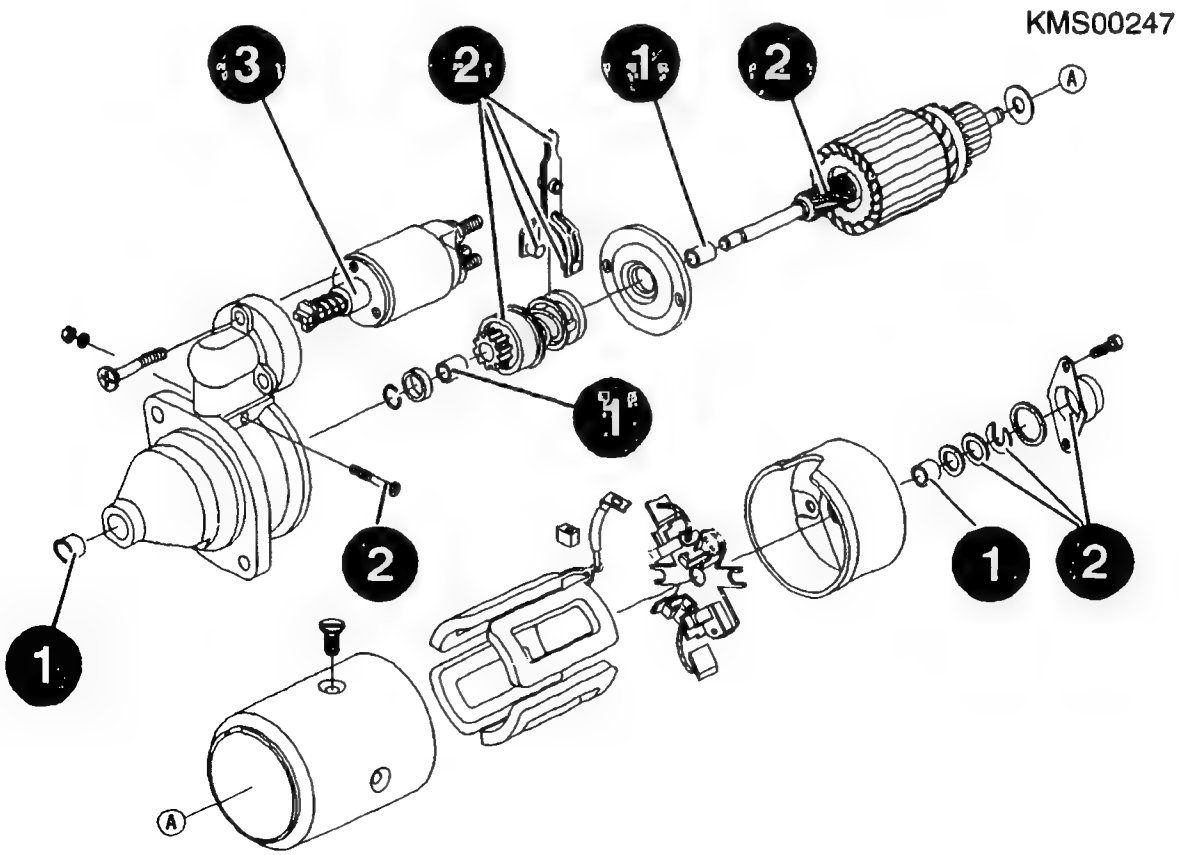
Continue: I23/1

LUBRICANTS/LUBRICATION CHART

Lubrication chart for starting-motor versions with sintered-metal bushing in gear unit

1	=	Oil VS 13 834-01	5 962 260 000
2	=	Grease VS 10832 Ft	5 932 240 000
3	=	Grease VS 16634 Ft	5 990 260 000

Continue: I24/1 Fig.: I23/2

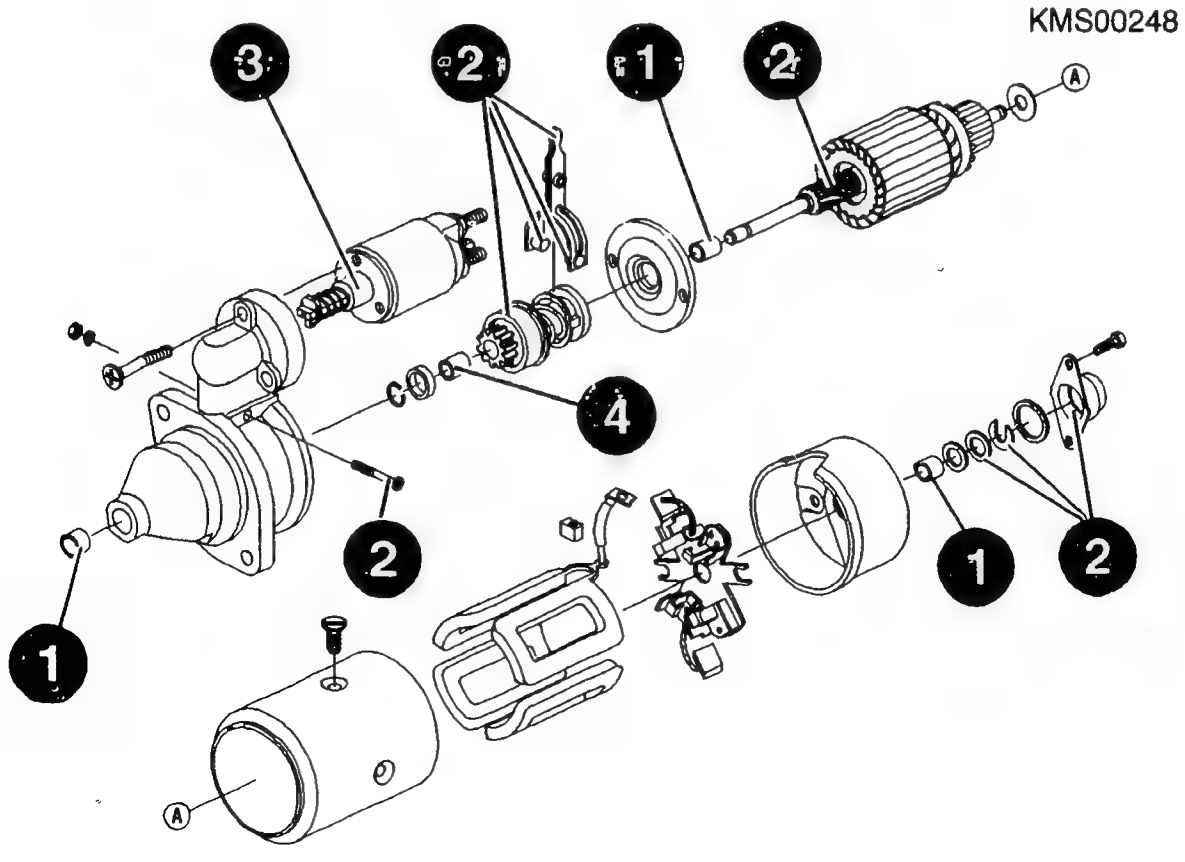


LUBRICANTS/LUBRICATION CHART

Lubrication chart for starting-motor versions with pocket-type bushing (Vandervell bushing) in gear unit

1	=	Oil VS 13 834-Öl	5 962 260 000
2	=	Grease VS 10832-Ft	5 932 240 000
3	=	Grease VS 16634 Ft	5 990 260 000
4	=	Grease VS 17427-Ft	5 995 778 000

Continue: I01/1 Fig.: I24/2

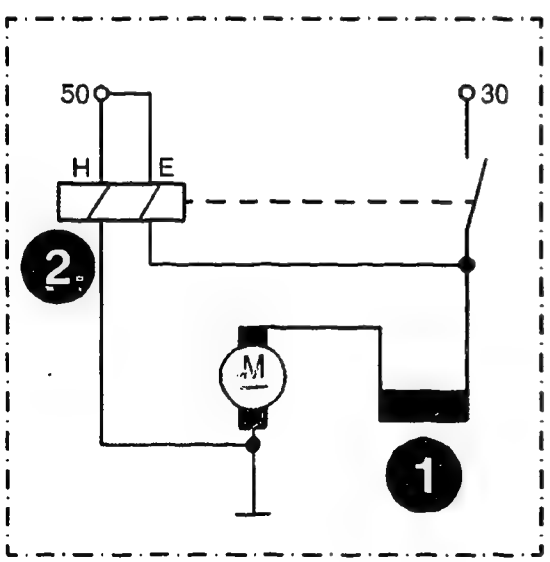


CIRCUIT DIAGRAM

1 = Excitation winding
2 = Solenoid switch

Continue: I01/1 Fig.: I25/2

KMS00249



STARTING-MOTOR DISASSEMBLY TABLE

Continue: I01/1

STARTING-MOTOR DISASSEMBLY

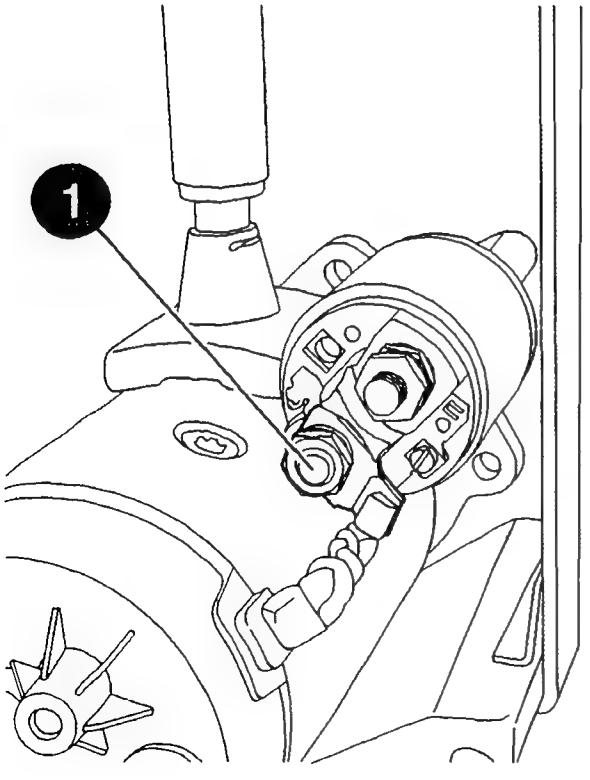
Solenoid-switch disassembly

Clamp starting motor in clamping support. Unfasten connection (1) of excitation winding at solenoid switch.

Clamping support: 0 986 619 362

Continue: I28/1 Fig.: I27/2

KMS00250



STARTING-MOTOR DISASSEMBLY

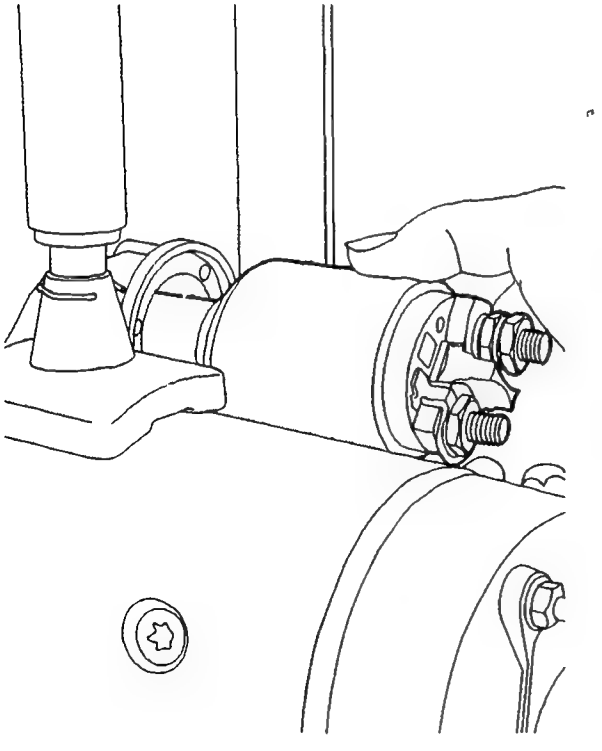
Solenoid-switch disassembly

Mark position of solenoid switch.
Unfasten relay screws.
ATTENTION: DANGER OF INJURY
The pretensioned return spring causes the solenoid switch to be pressed down by the relay armature.
Pull relay off relay armature.

Torx T25 bit: comm. avail.

Continue: II01/1 Fig.: I28/2

KMS00251



STARTING-MOTOR DISASSEMBLY

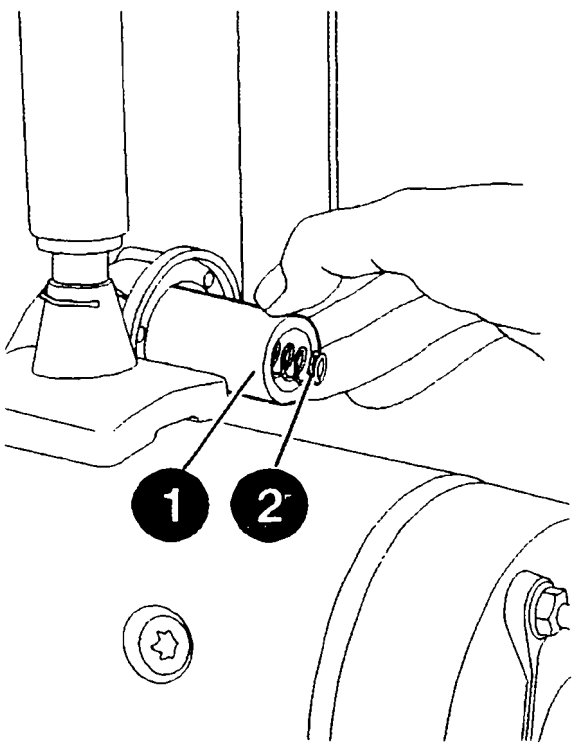
Solenoid-switch disassembly

Grasp hold of relay armature (1) and detach at engaging lever.

Pay attention to return spring (2) in relay armature.

Continue: I01/1 Fig.: II01/2

KMS00282



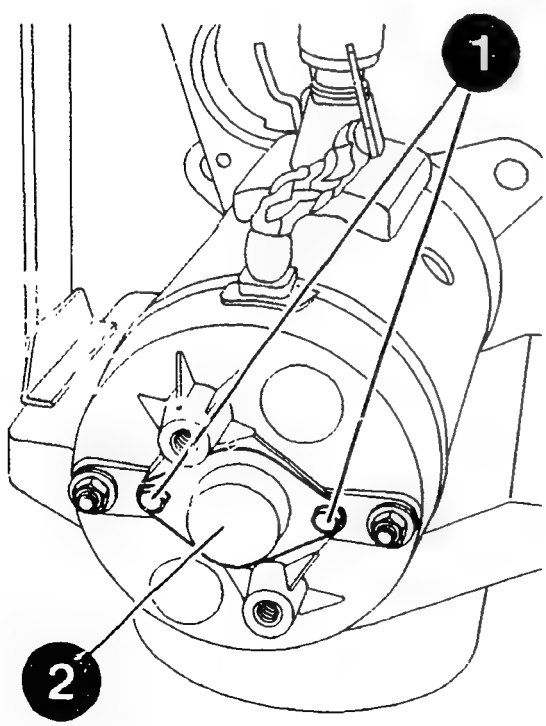
STARTING-MOTOR DISASSEMBLY

Bearing end plate disassembly

Turn starting motor round in clamp. Unfasten screws (1) of bearing end plate (2). Remove bearing end plate and seal.

Continue: II03/1 Fig.: II02/2

KMS00253



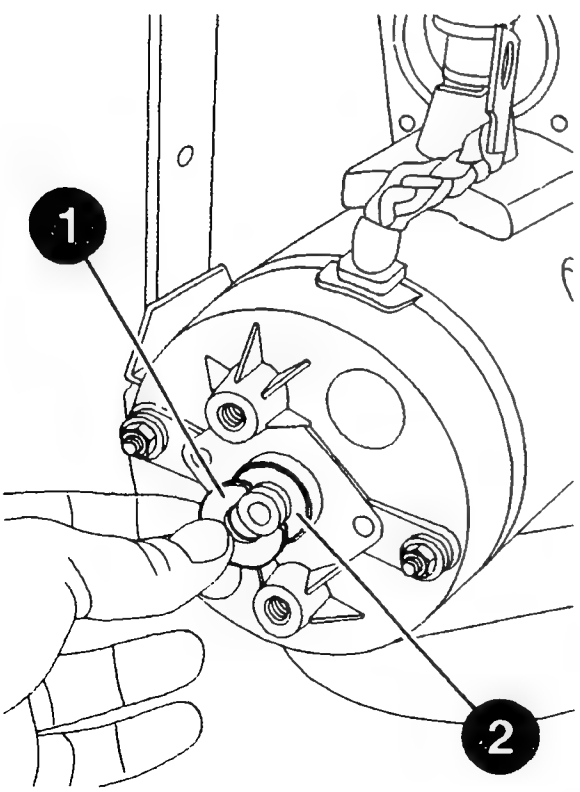
STARTING-MOTOR DISASSEMBLY

Bearing end plate disassembly

Remove locating washer (1) of armature shaft and shim (2).

Continue: I26/1 Fig.: II03/2

KMS00254



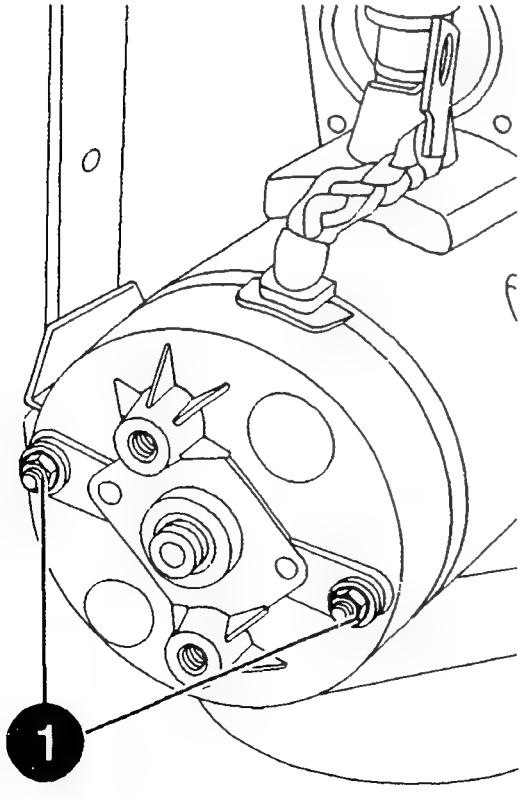
STARTING-MOTOR DISASSEMBLY

Commutator end shield disassembly

Unfasten nuts (1) of commutator end shield.
Remove commutator end shield.

Continue: I26/1 Fig.: II04/2

KMS00255



STARTING-MOTOR DISASSEMBLY

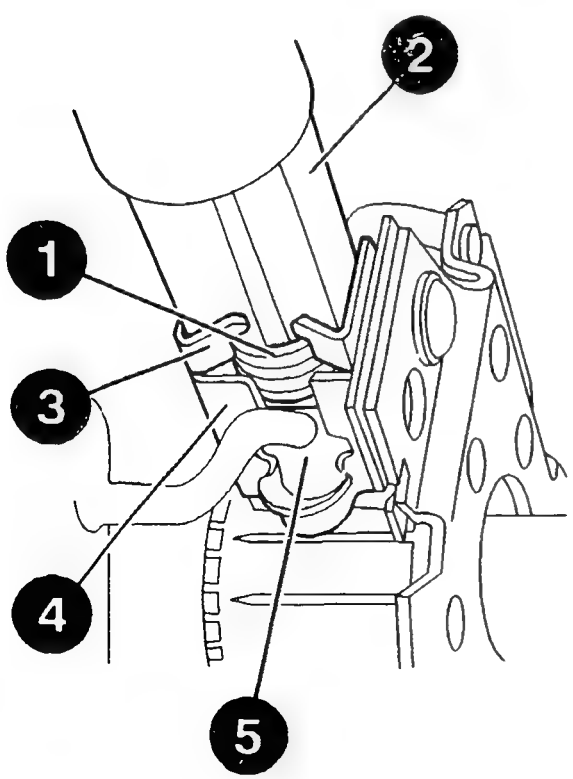
Carbon-brush disassembly

Press down helical compression spring (1) with assembly tool (2).

Carbon-brush assembly tool
Depending on type: 0 986 617 115
0 986 617 116
0 986 617 117

Continue: II06/1 Fig.: II05/2

KMS00215



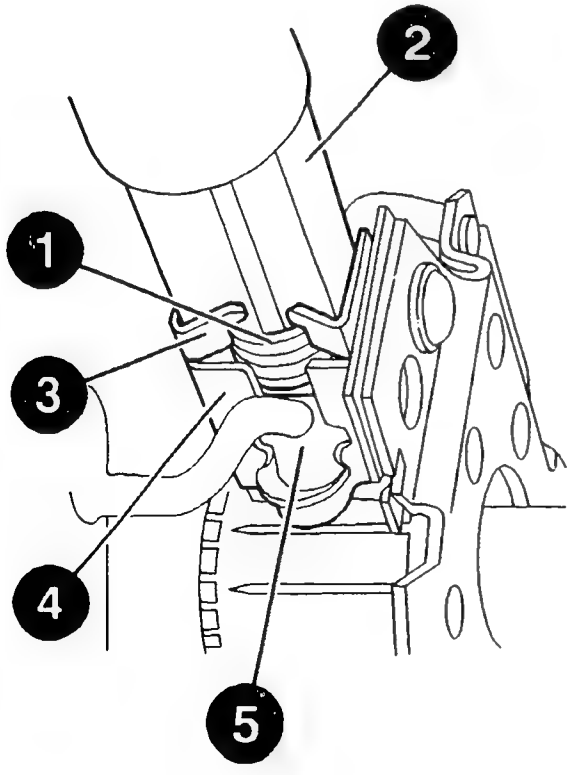
STARTING-MOTOR DISASSEMBLY

Carbon-brush disassembly

Bend open retaining lugs (3) of tubular brush holder (4) and remove helical compression spring (1).
ATTENTION: DANGER OF INJURY
Spring is pretensioned and jumps out on bending open the retaining lugs.
Remove both positive carbon brushes (5) from insulated tubular brush holders.

Continue: I26/1 Fig.: II06/2

KMS00215



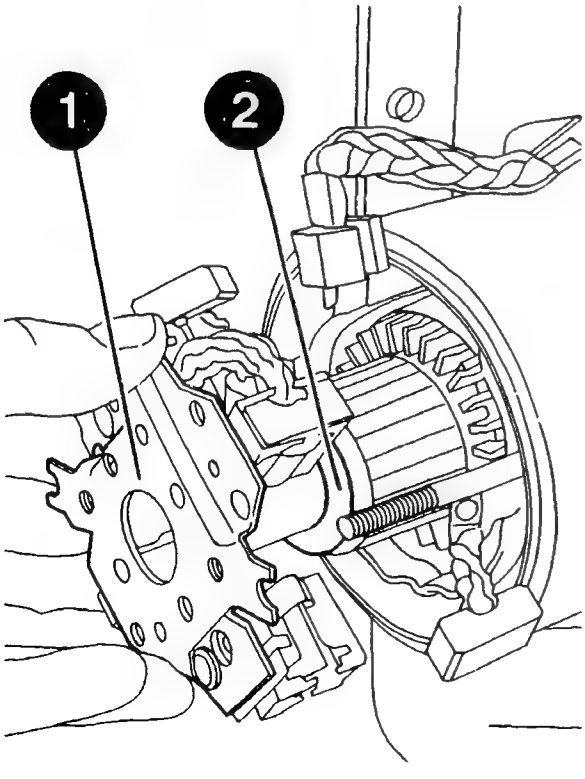
STARTING-MOTOR DISASSEMBLY

Brush-holder disassembly

Remove brush holder (1) and thrust washer (2) from armature shaft.

Continue: I26/1 Fig.: II07/2

KMS00256



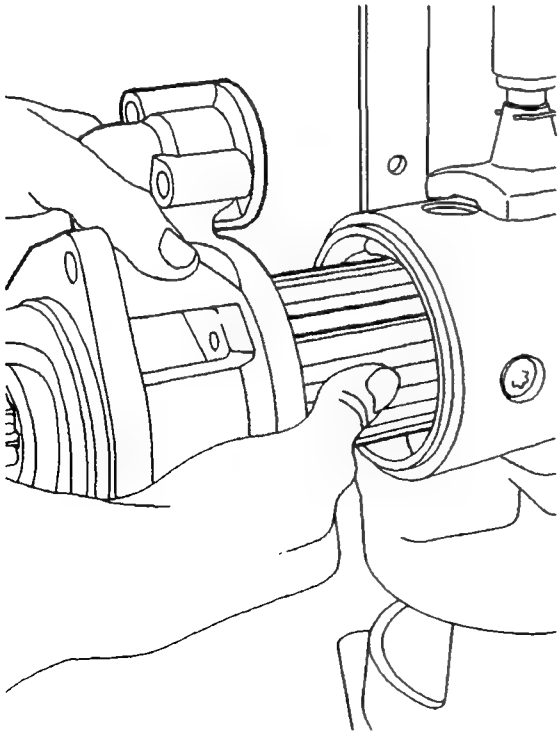
STARTING-MOTOR DISASSEMBLY

Drive-end bearing disassembly (Grey cast iron - closed type)

Mark position of drive-end bearing.
Pull drive-end bearing complete with armature off stator frame.
ATTENTION: Make sure stay bolts do not damage excitation winding.

Continue: II09/1 Fig.: II08/2

KMS00257



STARTING-MOTOR DISASSEMBLY

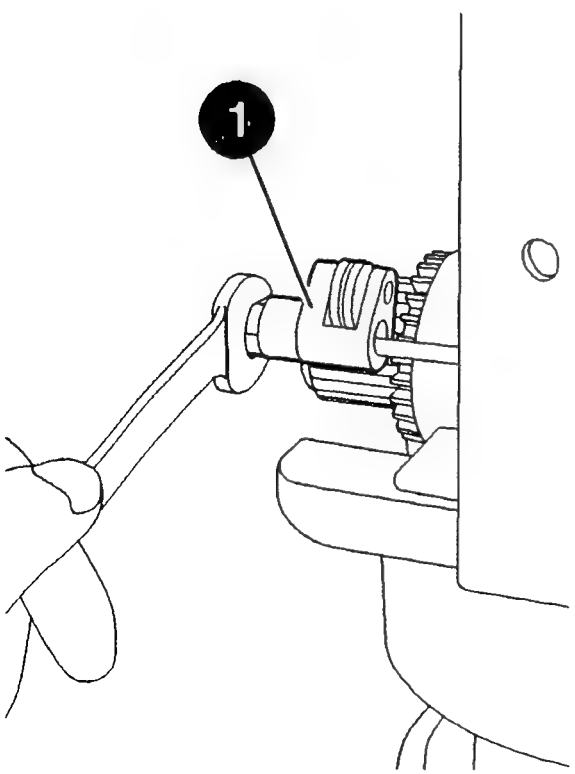
Drive-end bearing disassembly (Grey cast iron - closed type)

Clamp armature in clamping support. Use fitting and extraction tool (1) to screw both stay bolts out of drive-end bearing.

Clamping support:	0 986 619 362
Stay bolt fitting and extraction tool:	comm. avail.

Continue: II10/1 Fig.: II09/2

KMS00258



STARTING-MOTOR DISASSEMBLY

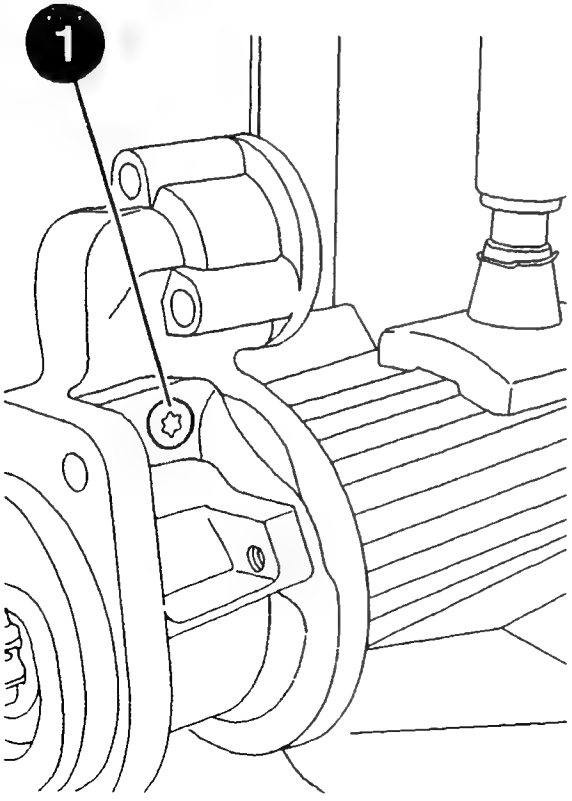
Drive-end bearing disassembly (Grey cast iron - closed type)

Unfasten bearing pin (1) of engaging lever and screw out of drive-end bearing.

Torx T40 bit: comm. avail.

Continue: II11/1 Fig.: II10/2

KMS00259



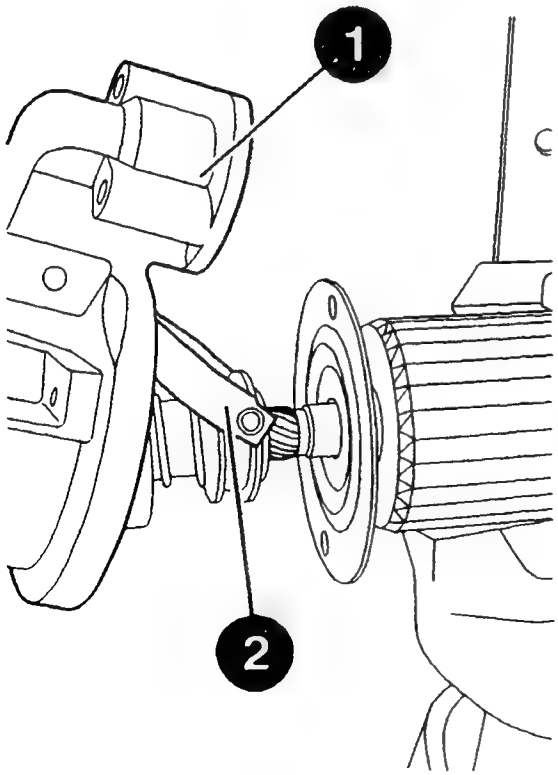
STARTING-MOTOR DISASSEMBLY

Drive-end bearing disassembly (Grey cast iron - closed type)

Remove drive-end bearing (1) and engaging lever (2) from armature.

Continue: I26/1 Fig.: II1 1/2

KMS00260



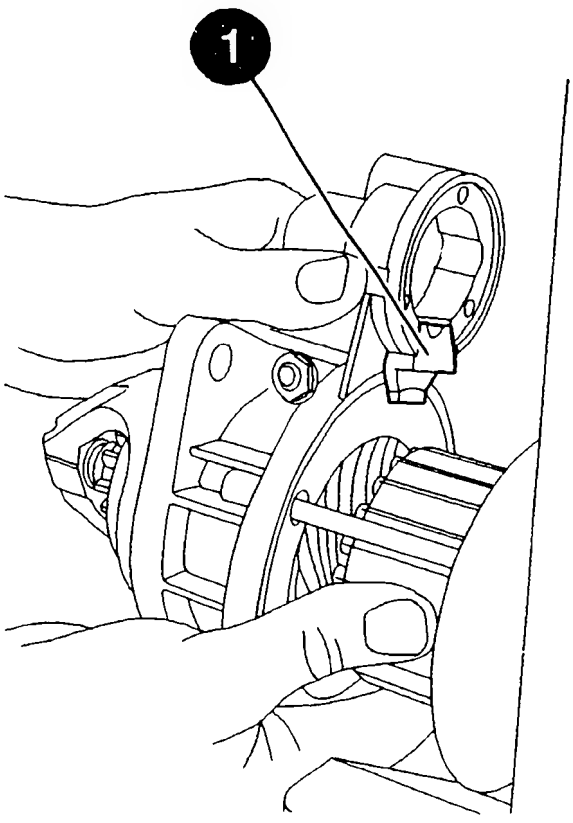
STARTING-MOTOR DISASSEMBLY

Drive-end bearing disassembly (Die-cast aluminum - open type)

Pull drive-end bearing complete with armature off stator frame.
ATTENTION: Make sure stay bolts do not damage excitation winding.
Remove gasket (1) with support plate.

Continue: II13/1 Fig.: II12/2

KMS00266



STARTING-MOTOR DISASSEMBLY

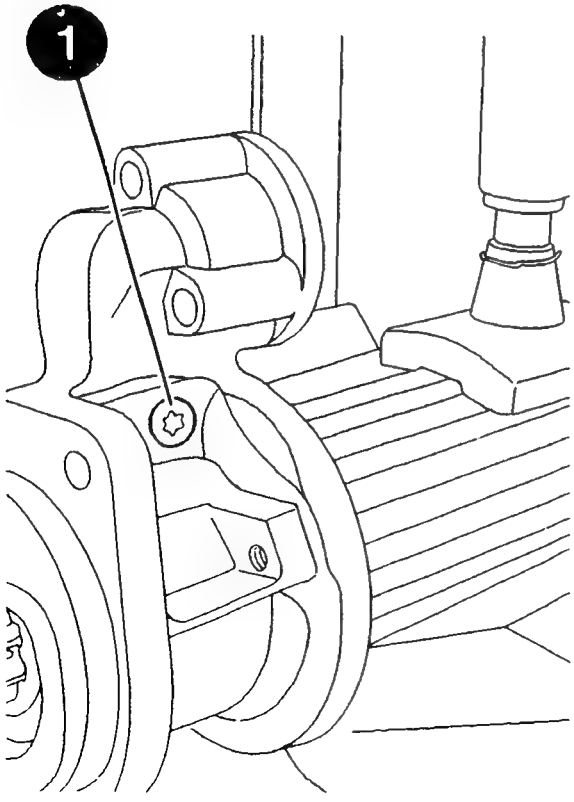
Drive-end bearing disassembly (Die-cast aluminum - open type)

Clamp armature in clamping support.
Screw bearing pin (1) of engaging lever out of drive-end bearing.

Clamping support:	0 986 619 362
Torx T40 bit:	comm. avail.

Continue: II14/1 Fig.: II13/2

KMS00259



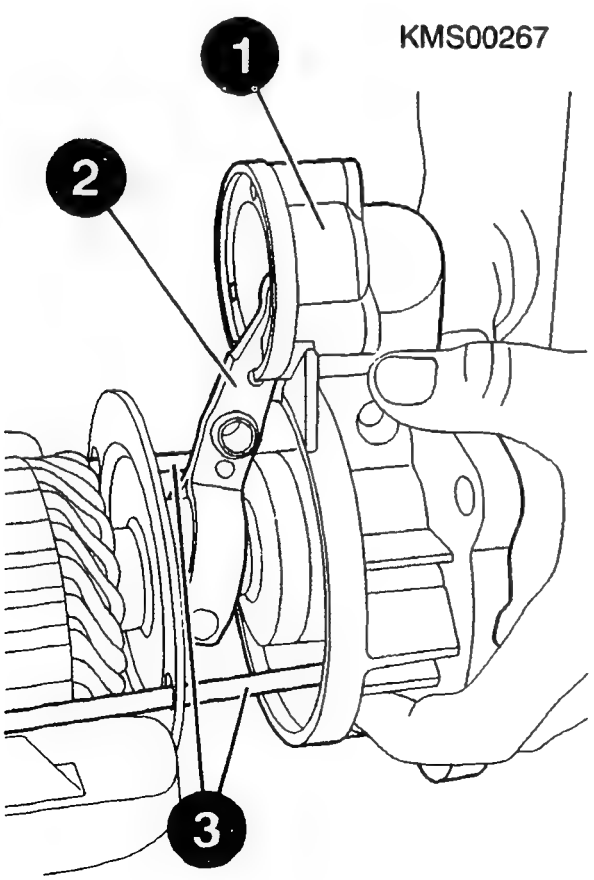
STARTING-MOTOR DISASSEMBLY

Drive-end bearing disassembly (Die-cast aluminum - open type)

Remove drive-end bearing (1) and engaging lever (2) from armature. Screw stay bolt (3) out of drive-end bearing.

Stay bolt fitting and extraction tool: comm. avail.

Continue: I26/1 Fig.: II14/2



STARTING-MOTOR DISASSEMBLY

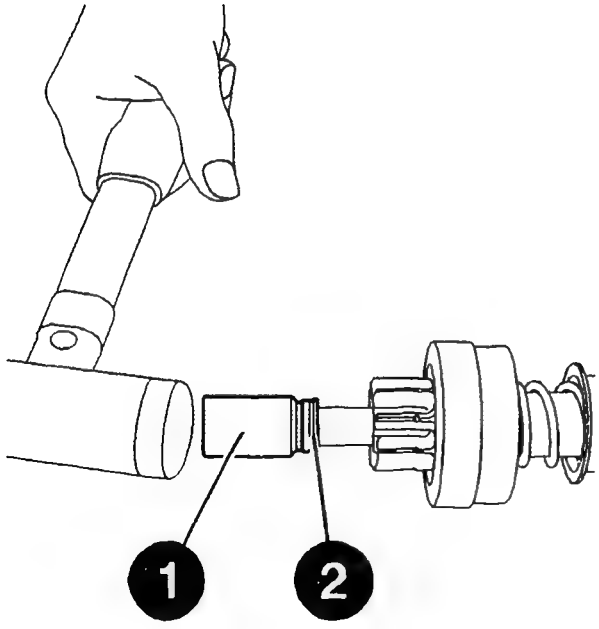
Gear-unit disassembly

Slip fitting sleeve (1) onto armature shaft.
Tap firmly with plastic-headed hammer on fitting sleeve to drive back stop ring (2).

Fitting sleeve for snap ring for armature-shaft diameter 14.2 mm: 0 986 617 114

Continue: II16/1 Fig.: II15/2

KMS00268



STARTING-MOTOR DISASSEMBLY

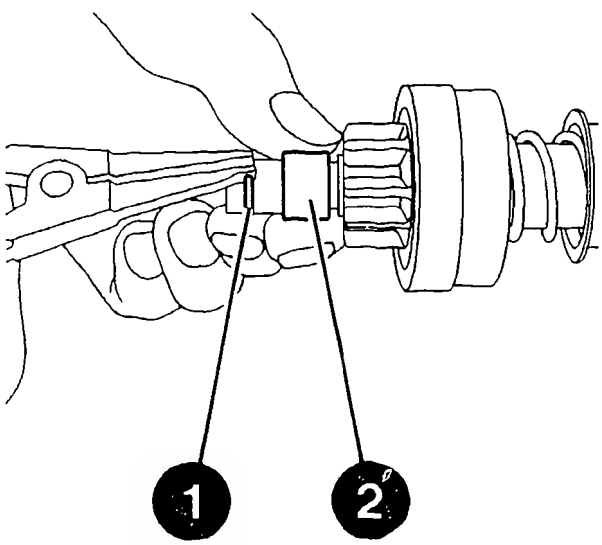
Gear-unit disassembly

Bend open snap ring (1) with pliers and pull off armature shaft.
Take care not to damage armature shaft when doing so.
Remove stop ring (2) from armature shaft.

Snap-ring pliers: comm. avail.

Continue: II17/1 Fig.: II16/2

KMS00269



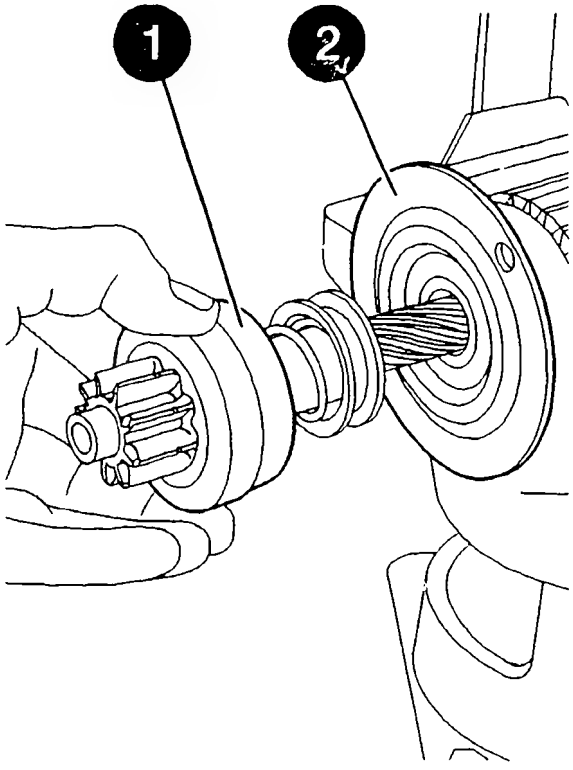
STARTING-MOTOR DISASSEMBLY

Gear-unit disassembly

Pull gear unit (1) and intermediate bearing (2) off armature shaft.

Continue: I26/1 Fig.: II17/2

KMS00270



COMPONENT CLEANING

Component cleaning:
Armatures, excitation windings, commutator end shields, relays and overrunning-clutch drives are only to be cleaned using compressed air (max. 4 bar) and a clean rag. Liquid cleaning agents are never to be employed.

Other parts such as intermediate bearings and drive-end bearings can be washed out in a commercially-available cleaning agent, provided that it is not readily flammable. Take care to avoid inhalation of vapors! Bushings must be re-lubricated and pocket-type bushings regreased.

Continue: II18/2

COMPONENT CLEANING

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Continue: II19/1

COMPONENT CLEANING

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: II19/2

COMPONENT CLEANING

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTING, REPAIR TABLE

Continue: II20/2

TESTING, REPAIR TABLE

Continue: I01/1

COMPONENT TESTING AND REPAIR

Testing pinion

Meshing pinion and overruning-clutch drive are subject to considerable wear. Overruning-clutch drive is therefore always to be replaced.

Continue: I01/2

COMPONENT TESTING AND REPAIR

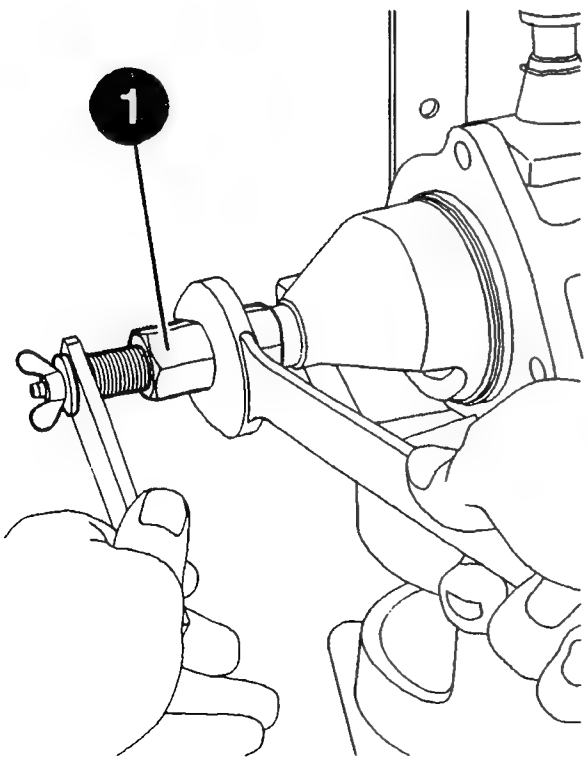
Testing drive-end bearing

Bushing of drive-end bearing is always to be replaced.
Removing: Clamp drive-end bearing in clamping support. Use puller (1) and spring collet to pull bushing out of drive-end bearing.

Clamping support:	0 986 619 362
Puller:	0 986 617 243
Spring collet diameter 12.5 mm:	0 986 617 246

Continue: II23/1 Fig.: II22/2

KMS00271



COMPONENT TESTING AND REPAIR

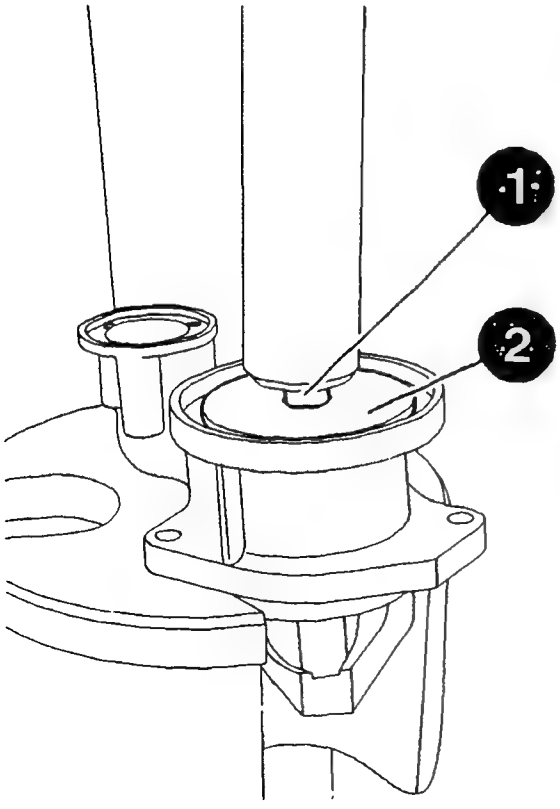
Testing drive-end bearing

Installing: Press new bushing from inside into drive-end bearing with fitting mandrel (1). Make sure plate washer (2) of fitting mandrel is properly centered in flange of drive-end bearing.
ATTENTION: Soak new bushing in oil beforehand for 1 hour.

Mandrel press:	comm. avail.
Fitting mandrel with plate washer, dia. 12.5 mm:	0 986 617 212
Oil VS 13 834-Ö1:	5 962 260 000

Continue: II20/1 Fig.: II23/2

KMS00272



COMPONENT TESTING AND REPAIR

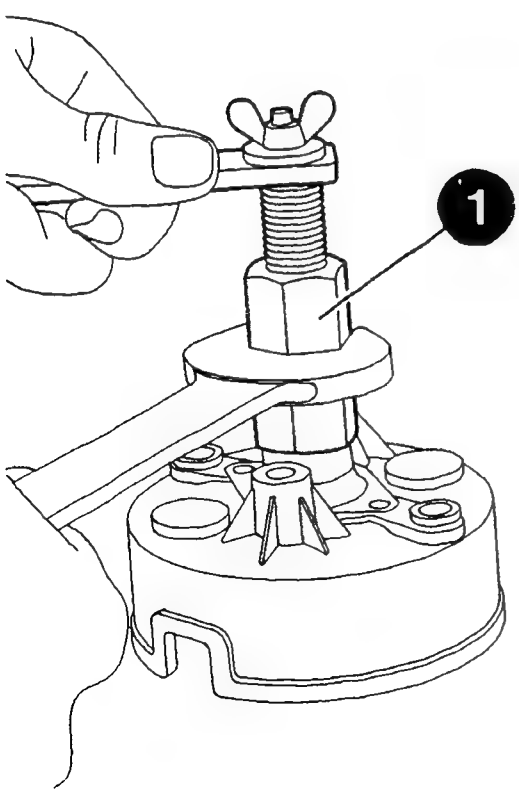
Testing commutator end shield

Check bushing for damage and running marks.
Replace if applicable.
Removing: Use puller (1) and spring collet to pull bushing out of commutator end shield.

Puller:	0 986 617 243
Spring collet diameter 14.3 mm:	0 986 617 251

Continue: II25/1 Fig.: II24/2

KMS00222



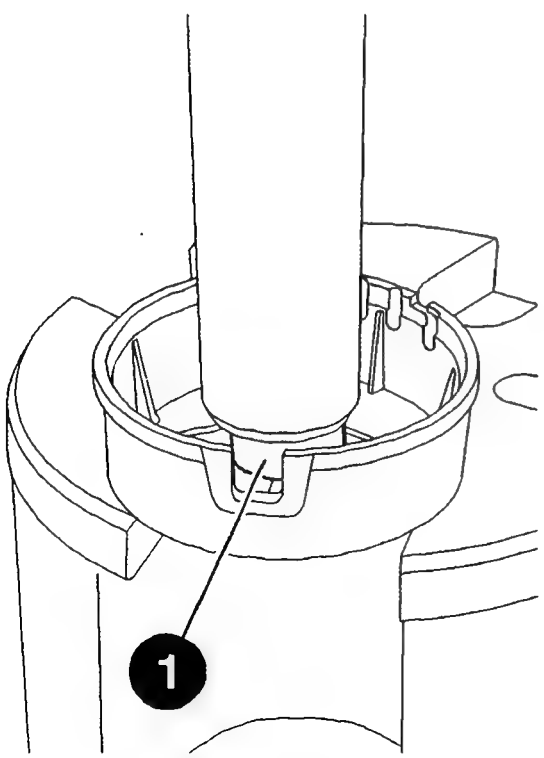
Testing commutator end shield

Installing: Use fitting mandrel (1) to press new bushing into commutator end shield from inside.
ATTENTION: Soak new bushing beforehand in oil for 1 hour.

Mandrel press:	comm. avail.
Fitting mandrel for bushing diameter 14.3 mm in commutator end shield:	Own make
Oil v 13:	5 701 042 511

Continue: II20/1 Fig.: II25/2

KMS00223



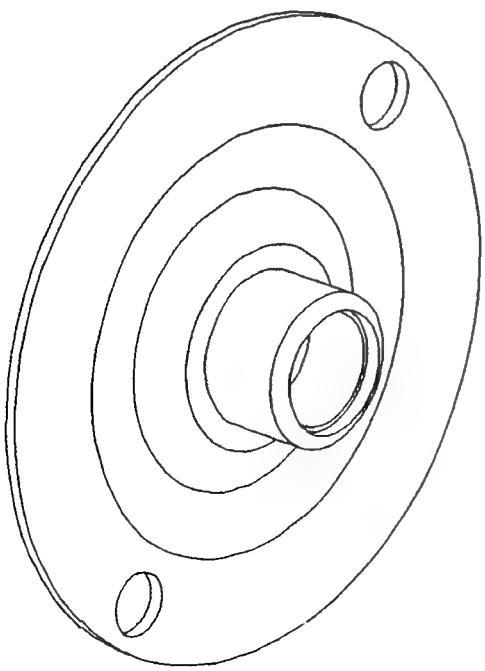
COMPONENT TESTING AND REPAIR

Testing intermediate bearing (sheet steel)

The bushing cannot be replaced. The entire intermediate bearing must be renewed if bushing shows signs of running marks or damage.

Continue: II20/1 Fig.: II26/2

KMS00273



COMPONENT TESTING AND REPAIR

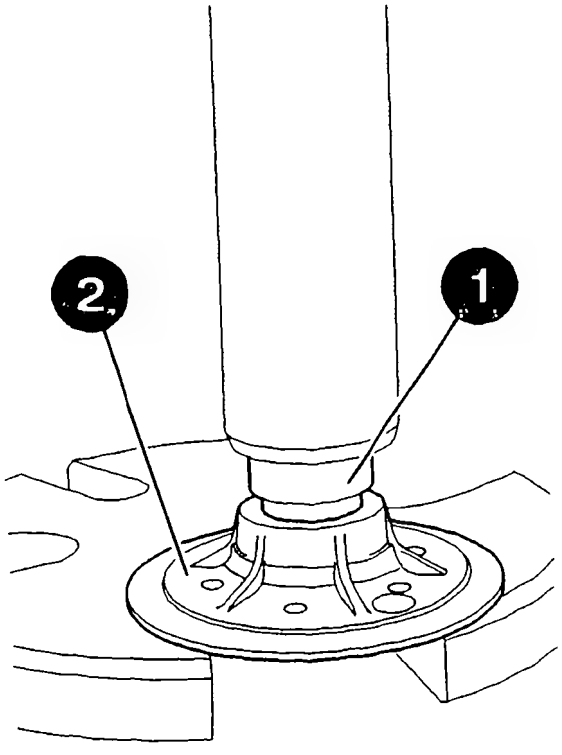
Testing intermediate bearing (cast iron)

Check bushing for damage and running marks.
Replace if appropriate.
Removing: Use extraction mandrel (1) to press bushing out of intermediate bearing (2).

Mandrel press:	comm. avail.
Exctraction mandrel for bushing diameter 18.9 mm in intermediate bearing:	Own make

Continue: II28/1 Fig.: II27/2

KMS00180



COMPONENT TESTING AND REPAIR

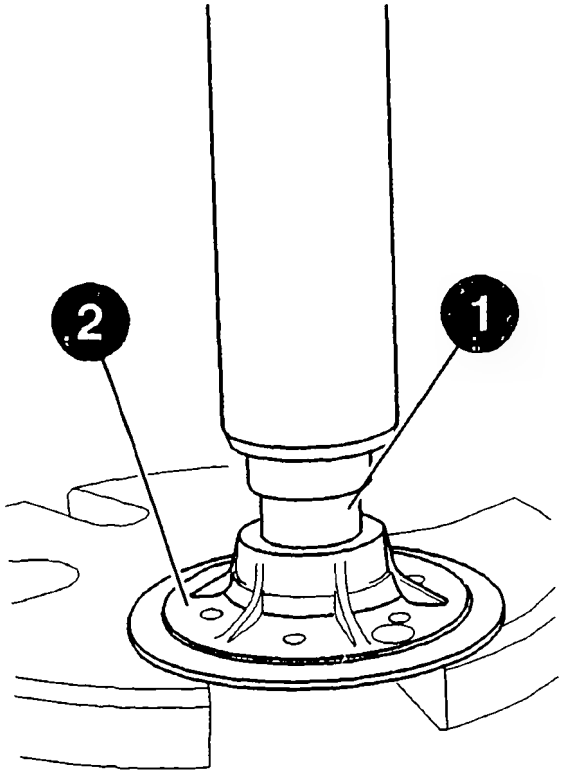
Testing intermediate bearing (cast iron)

Installing: Use fitting mandrel (1) to press new bushing into intermediate bearing (2).
ATTENTION: Soak new bushing beforehand in oil for 1 hour.

Mandrel press:	comm. avail.
Fitting mandrel for bushing diameter 18.9 mm in intermediate bearing:	Own make
Oil VS 13 834-Öl:	5 962 260 000

Continue: II20/1 Fig.: II28/2

KMS00274



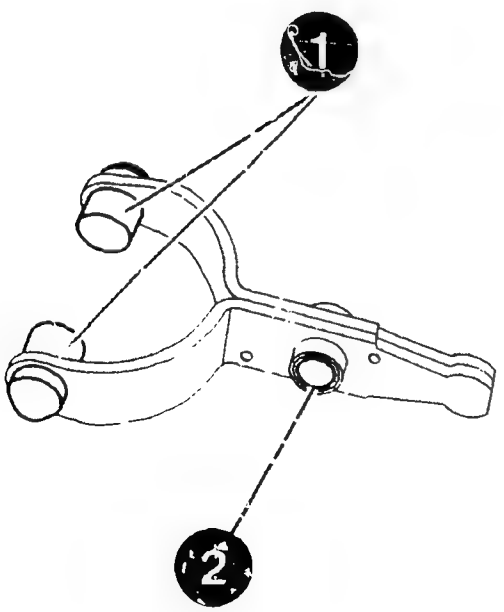
COMPONENT TESTING AND REPAIR

Testing engaging lever

Engaging lever must be replaced if guide pins (1) or bushing (2) are/ is worn.

Continue: II20/1 Fig.: III01/2

KMS00275



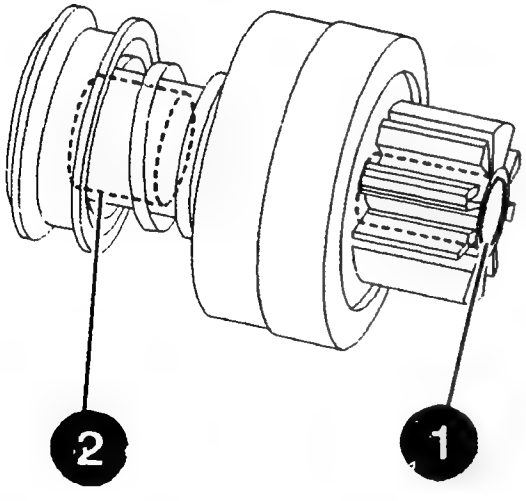
COMPONENT TESTING AND REPAIR

Testing gear unit

Bushing (1), spiral spline (2) and driver edges of overrunning-clutch drive are subject to considerable wear.
Overrunning-clutch drive is therefore always to be replaced.

Continue: II20/1 Fig.: III02/2

KMS00304



COMPONENT TESTING AND REPAIR

Testing carbon brushes

Carbon brushes and helical compression springs are always to be replaced. Make exclusive use of replacement parts listed in service parts list for appropriate starting motor.

Continue: III04/1

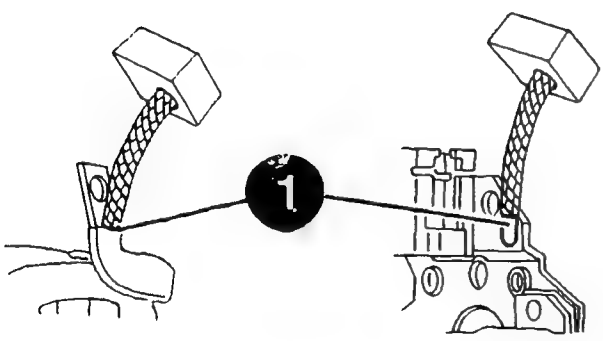
COMPONENT TESTING AND REPAIR

Testing carbon brushes

Removing: Pinch off standard wires of carbon brushes at soldered joint (1) at excitation winding/brush holder.

Continue: III05/1 Fig.: III04/2

KMS00224

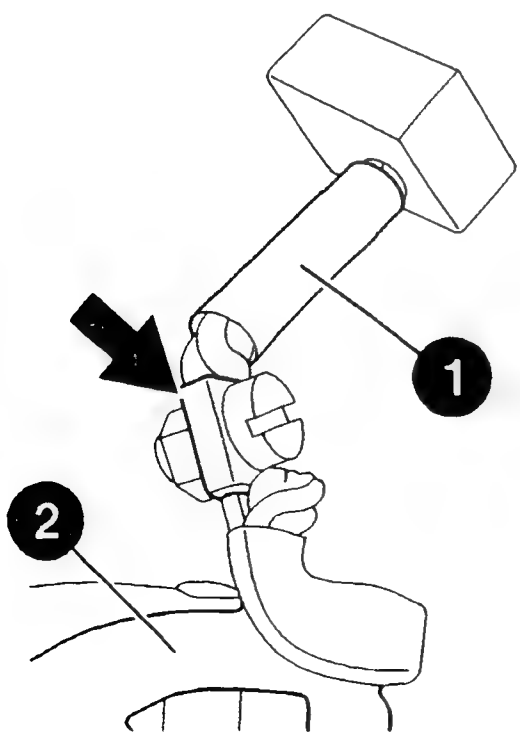


Testing carbon brushes

Installing positive carbon brushes: Screw (working inwards) replacement carbon brushes with red insulating sleeve (1) to excitation winding (2). Make sure terminals are properly positioned to ensure that they do not turn (see arrow).

Continue: III06/1 Fig.: III05/2

KMS00225



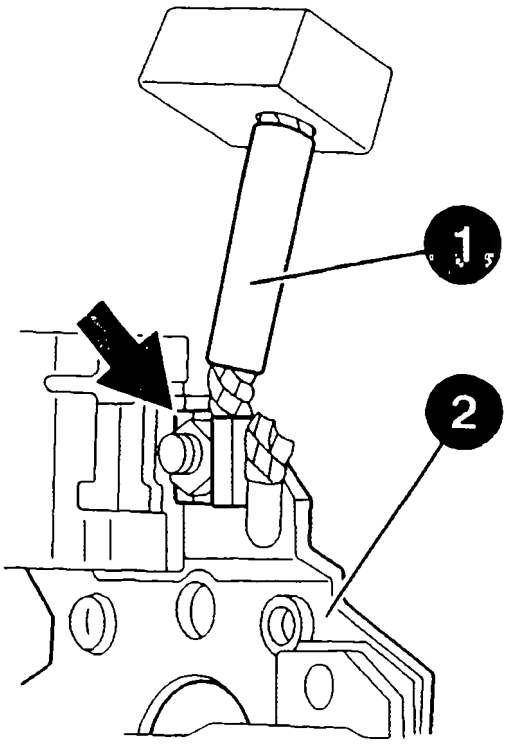
COMPONENT TESTING AND REPAIR

Testing carbon brushes

Installing negative carbon brushes: Screw (working inwards) replacement carbon brushes with blue insulating sleeve (1) to brush-holder plate (2). Make sure terminals are properly positioned to ensure that they do not turn (see arrow).

Continue: II20/1 Fig.: III06/2

KMS00226



COMPONENT TESTING AND REPAIR

Testing brush holder

Check tubular brush holders (1), which are insulated from brush holder (2), for short to ground.

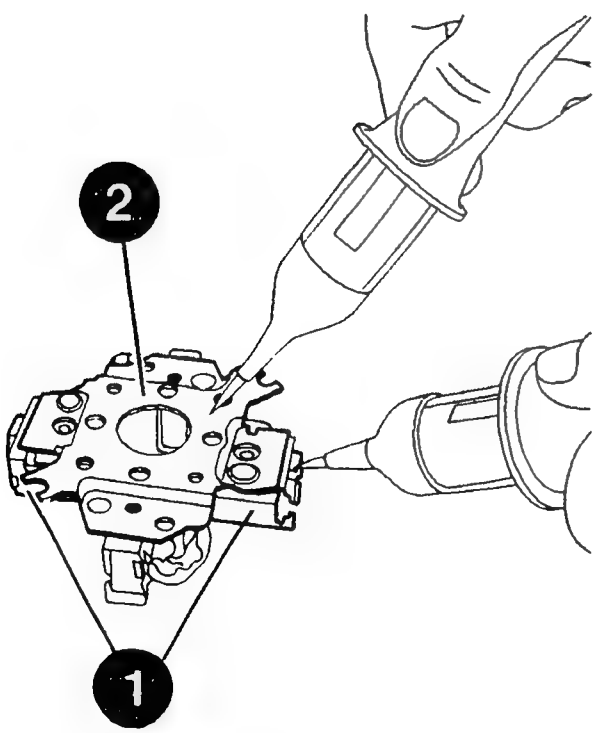
Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101

Ground-short test voltage	
12 V starting motor:	40 V*
24 V starting motor:	80 V*

* = AC voltage

Continue: III08/1 Fig.: III07/2

KMS00227



Testing brush holder

If brush holder is replaced, carbon brushes and helical compression springs are to be renewed as well.

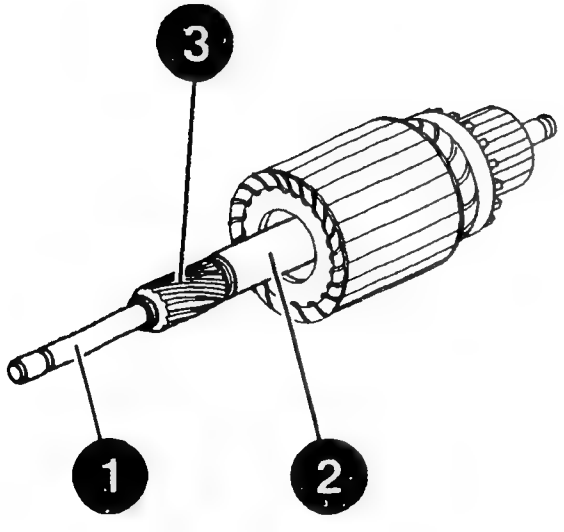
Continue: II20/2

Testing armature

Examine bearing surfaces of over-running clutch drive (1) and intermediate bearing (2) as well as spiral spline (3) for running marks and damage.
Replace armature if necessary.

Continue: III10/1 Fig.: III09/2

KMS00276



COMPONENT TESTING AND REPAIR

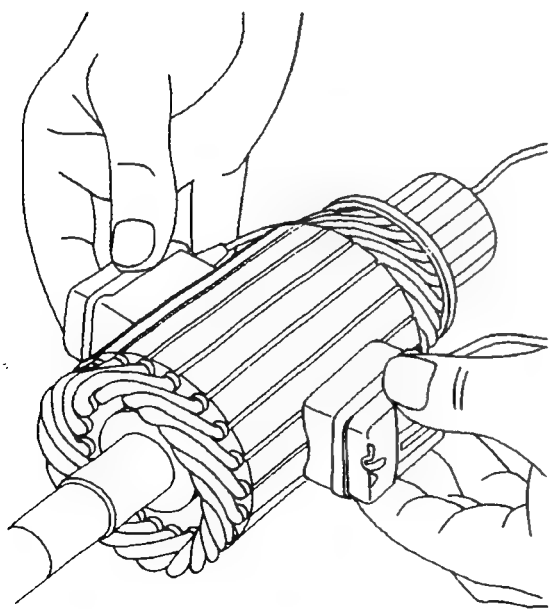
Testing armature

Check armature for interturn short circuit using tester and test probes.

Interturn short-circuit tester with test probes: 0 986 619 110

Continue: III11/1 Fig.: III10/2

KMS00228



COMPONENT TESTING AND REPAIR

Testing armature

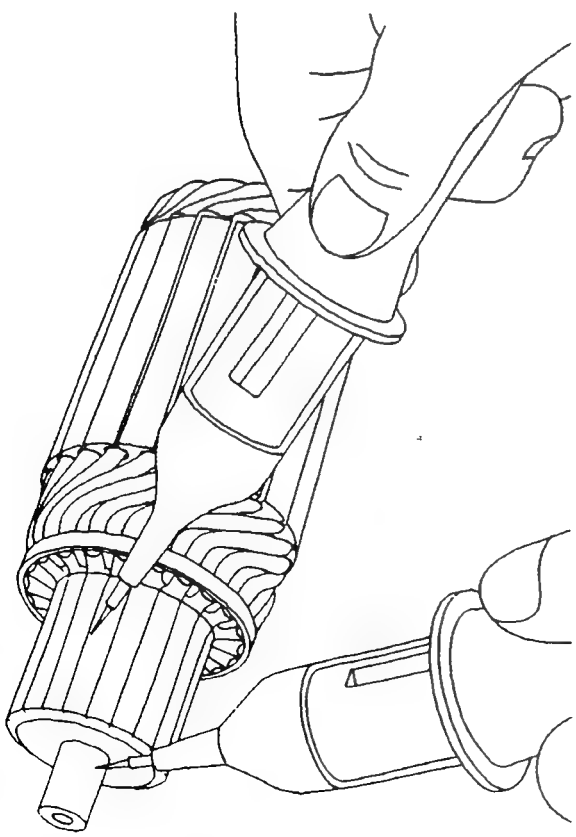
Use tester and test prods to check armature for short to ground and continuity (black laminations indicate open circuit).

Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101
Ground-short test voltage	
12 V starting motor:	40 V*
24 V starting motor:	80 V*
Continuity test voltage:	40 V*

* = AC voltage

Continue: II20/2 Fig.: III11/2

KMS00229



Testing commutator

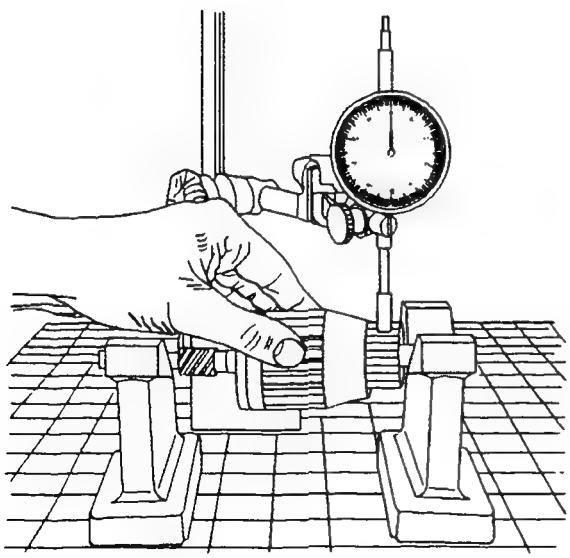
Check commutator concentricity.
If radial run-out is outside stated range, commutator must be turned down.

Magnetic measurement stand:	4 851 601 124
Dial indicator:	1 687 233 011

Radial run-out - Commutator:	max. 0,03 mm

Continue: III13/1 Fig.: III12/2

KMS00192



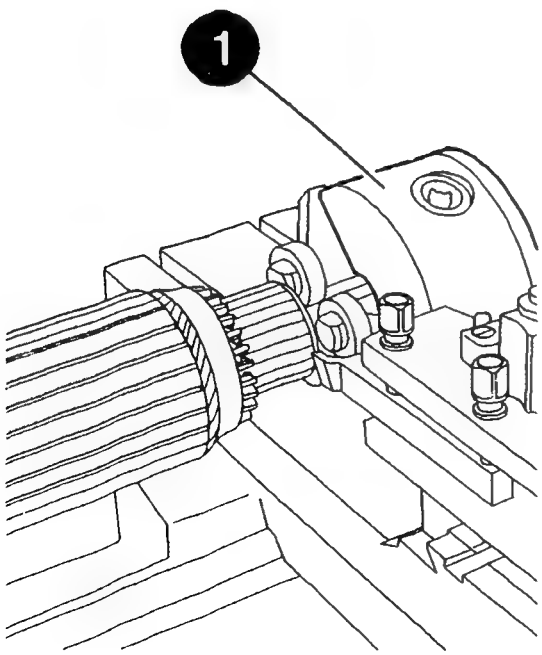
Testing commutator

Turning down involves positioning armature in three-jaw chuck and tailstock rest (1). The max. machining thickness is 0.03 mm.
Pay attention to minimum diameter.

Tailstock rest with Morse taper 2:	0 986 619 156
Mininum diameter:	42,5 mm

Continue: III14/1 Fig.: III13/2

KMS00193



Testing commutator

ATTENTION: On starting motors manufactured before FD 461, the insulation of the commutator laminations contains asbestos.
A suitable extractor is to be used when machining.
Starting motors as of FD 461 are asbestos-free.

After being turned down, the insulation of the commutator laminations must be sawn out with an appropriate tool to a depth of 0.8 mm.

Continue: III14/2

A suitable extraction system must be employed if a commutator saw is used. Then finish-turn commutator and check again for interturn short circuit and ground short. Pay attention to commutator minimum diameter.

Interturn short-circuit tester:	0 986 619 110
Minimum diameter:	42,5 mm
Ground-short test voltage	
12 V starting motor:	40 V*
24 V starting motor:	80 V*

* = AC voltage

Continue: II20/2

COMPONENT TESTING AND REPAIR

Testing excitation winding

Use tester and test prods to check winding for short to ground.

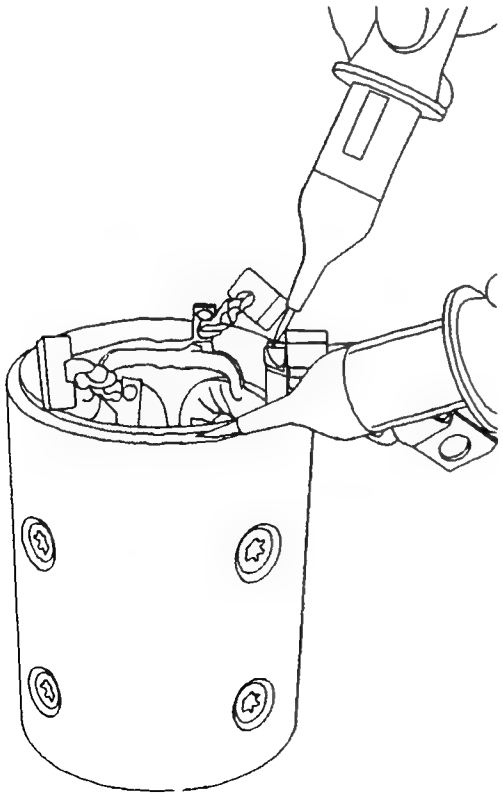
Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101

Ground-short test voltage	
12 V starting motor:	40 V*
24 V starting motor:	80 V*

* = AC voltage

Continue: III16/1 Fig.: III15/2

KMS00230



COMPONENT TESTING AND REPAIR

Testing excitation winding

Use tester and test prods to check winding for continuity.

Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101

Continuity test voltage: 40 V*
* = AC voltage

Continue: II20/2 Fig.: III16/2

KMS00231

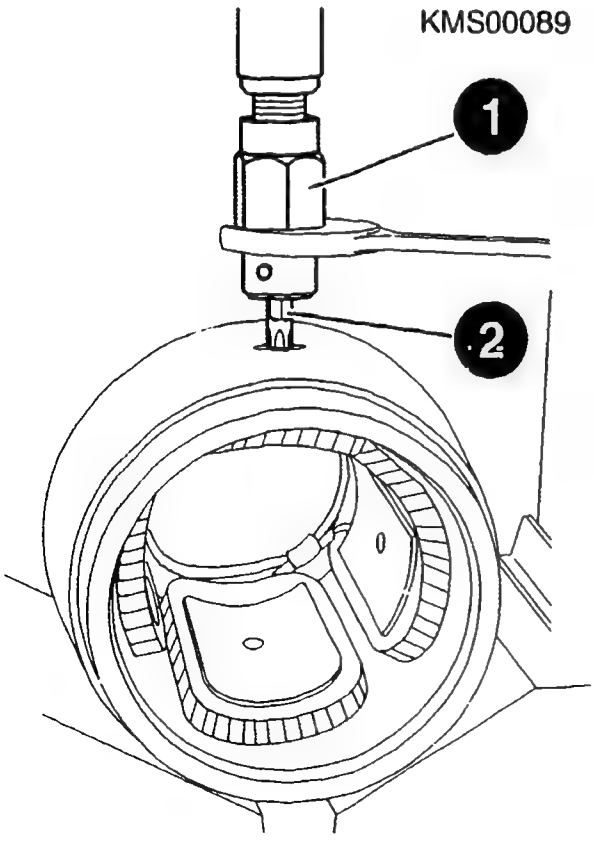
COMPONENT TESTING AND REPAIR

Replacing excitation winding

Replace damaged, defective, scorched or unsoldered windings.
Removing: Insert stator frame in clamping support, mark position of pole shoes.
Unfasten pole-shoe bolts with pole-shoe screwdriver (1) and Torx bit (2); remove pole shoes and winding in direction of drive-end bearing.

Clamping support:	0 986 619 362
Pole-shoe screwdriver:	0 986 619 393
Torx T50 bit with 5/16" hexagon:	comm. avail.

Continue: III18/1 Fig.: III17/2



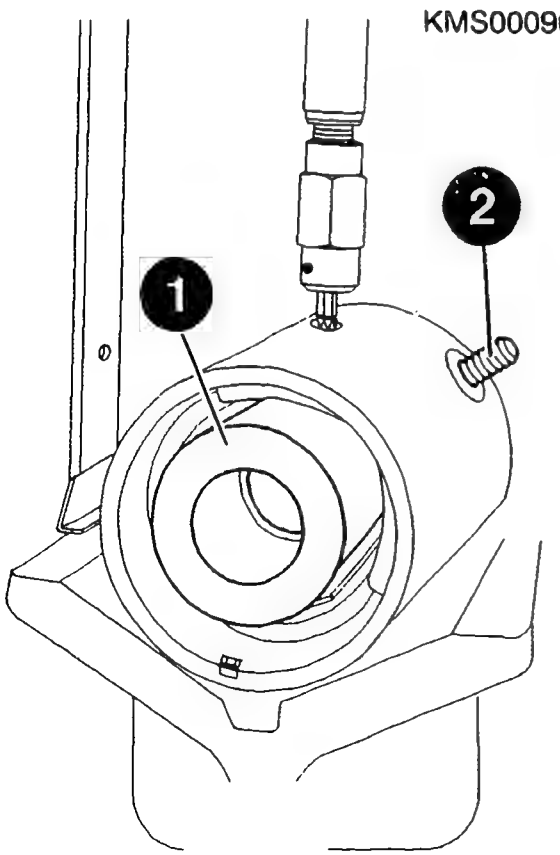
COMPONENT TESTING AND REPAIR

Replacing excitation winding

Installing: Heat excitation winding before fitting, insert with pole shoes from drive end in stator frame and slightly tighten pole-shoe bolts. Pay attention to markings.
Press in fitting mandrel (1).

Mandrel press:	comm. avail.
Fitting mandrel diameter:	75,80...75,85 mm (own make)

Continue: III19/1 Fig.: III18/2



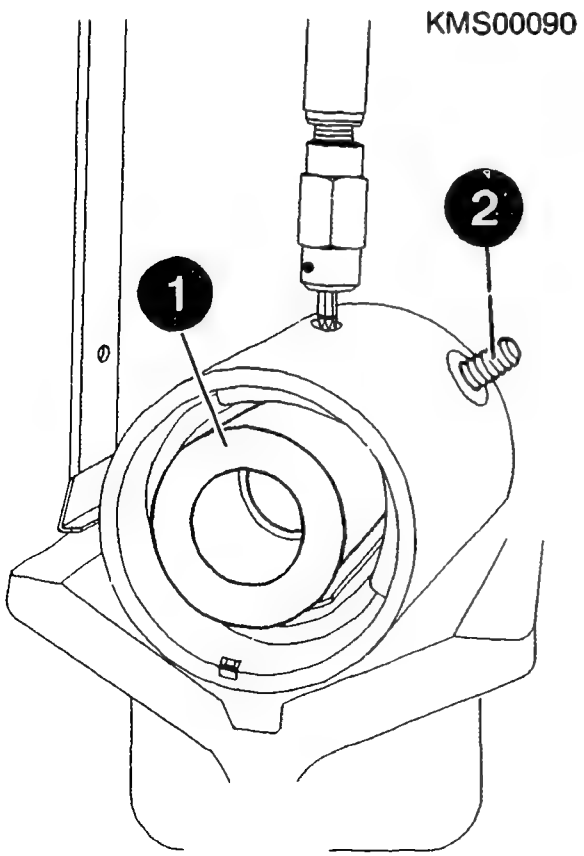
COMPONENT TESTING AND REPAIR

Replacing excitation winding

Tighten pole-shoe bolts and press out fitting mandrel (1).

Mandrel press:	comm. avail.
Pole-shoe screwdriver:	0 986 619 393
Torx T50 bit with 5/16" hexagon:	comm. avail.
Torque wrench:	comm. avail.
Tightening torque of pole-shoe bolts:	40...55 Nm

Continue: II20/2 Fig.: III19/2



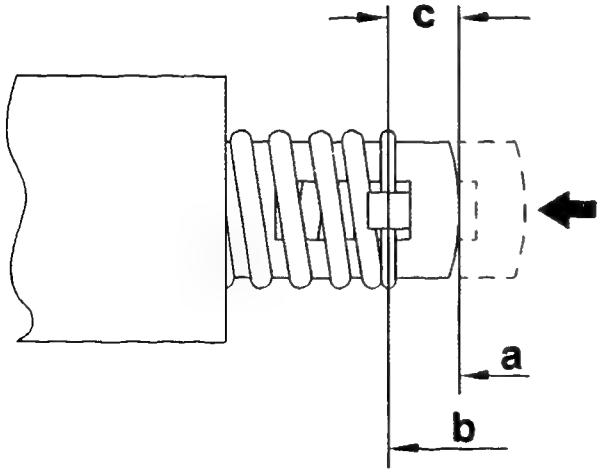
COMPONENT TESTING AND REPAIR

Testing solenoid switch

Examine solenoid switch for damage.
Check burn-off reserve.
Press in armature by hand until current bridge is resting (a) on terminal stud. On pressing in the armature further as far as stop (b) a noticeable increase in force is apparent. The difference between positions (a) and (b) is the burn-off reserve (c). If there is no further burn-off reserve, the solenoid switch must be replaced.

Continue: III21/1 Fig.: III20/2

KMS00303



COMPONENT TESTING AND REPAIR

Testing solenoid switch

Use tester to check resistance of pull-in winding (term. 50/term. 30-f).

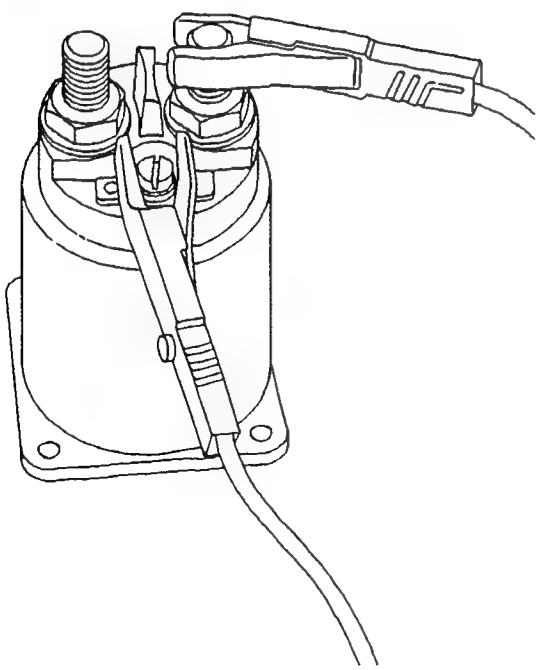
Alternator tester: 0 684 201 200

Resistances

-12V- Starting motor:	0,23...0,25 Ohm
-24V- Starting motor:	
Type IF 0 001 363...:	1,51...1,65 Ohm
Type IF 0 001 368...:	1,27...1,39 Ohm
Type IF 0 001 364...:	1,05...1,11 Ohm

Continue: III22/1 Fig.: III21/2

KMS00239



COMPONENT TESTING AND REPAIR

Testing solenoid switch

Use tester to check resistance of holding winding (term. 50/ground).

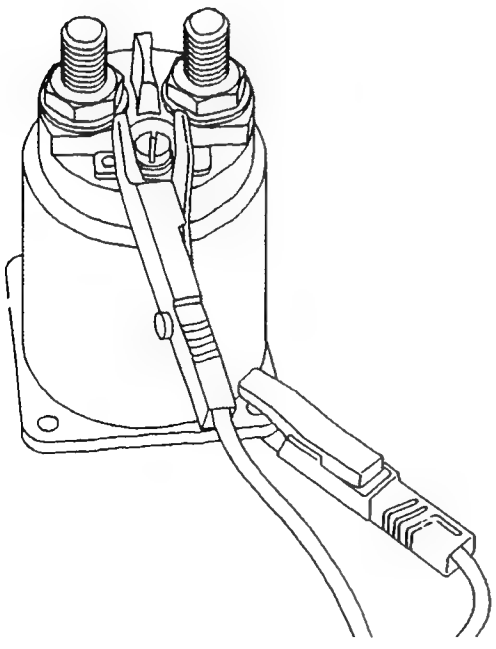
Alternator tester: 0 684 201 200

Resistances

-12V- Starting motor:	1,00...1,10 Ohm
-24V- Starting motor:	
Type IF 0 001 363...:	4,40...4,80 Ohm
Type IF 0 001 368...:	4,14...4,64 Ohm
Type IF 0 001 364...:	3,34...3,52 Ohm

Continue: III23/1 Fig.: III22/2

KMS00240



COMPONENT TESTING AND REPAIR

Testing solenoid switch

Neither the tests described, nor proper functioning of the solenoid switch when testing the function of the starting motor following repairs can provide reliable information on long-term trouble-free operation of the solenoid switch.
It is therefore advisable to renew the solenoid switch when the starting motor is repaired.

Continue: II20/2

STARTING-MOTOR ASSEMBLY TABLE

Continue: III24/2

STARTING-MOTOR ASSEMBLY TABLE

Continue: I01/1

STARTING-MOTOR ASSEMBLY

Intermediate bearing assembly

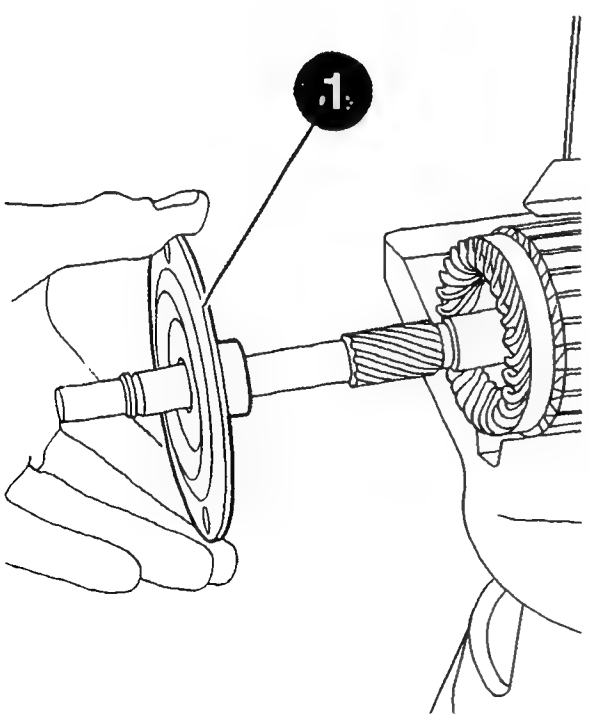
Lubricate as per lubrication chart before and during assembly.

Clamp armature in clamping support. Slip intermediate bearing (1) onto armature shaft with collar facing armature winding.

Clamping support: 0 986 619 362

Continue: I01/2 Fig.: III25/2

KMS00277



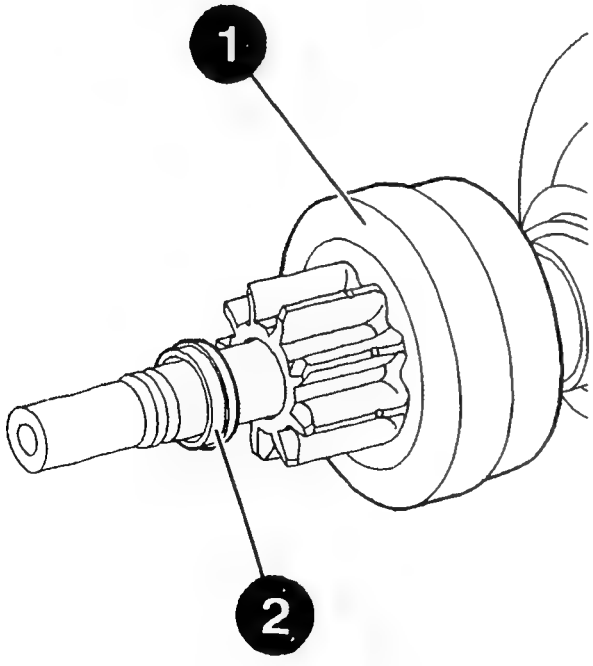
STARTING-MOTOR ASSEMBLY

Gear-unit assembly

Slip gear unit (1) and new stop ring (2) with collar facing armature winding onto armature shaft.
ATTENTION: Spiral spline of gear unit must be dry and free from grease to stop armature shaft becoming pasty. Only grease armature spiral spline. If gear unit features pocket-type bushing (Vandervell bushing) fill pockets with grease prior to gear-unit assembly.

Continue: III27/1 Fig.: III26/2

KMS00278



STARTING-MOTOR ASSEMBLY

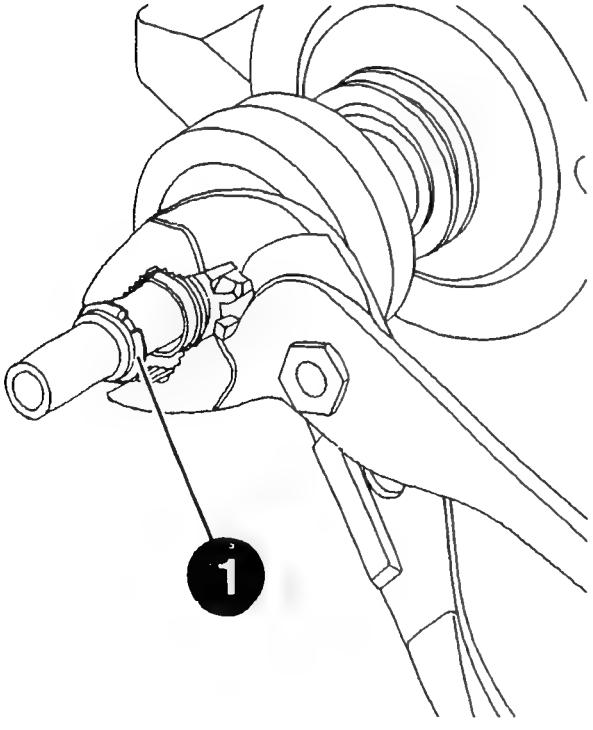
Gear-unit assembly

Bend open new snap ring (1) with pliers and insert in armature annular groove. Use gripping pliers to squeeze together snap ring in annular groove.
ATTENTION: Take care not to damage armature shaft when doing so.

Snap-ring pliers:	comm. avail.
Gripping pliers:	comm. avail.

Continue: III28/1 Fig.: III27/2

KMS00279



STARTING-MOTOR ASSEMBLY

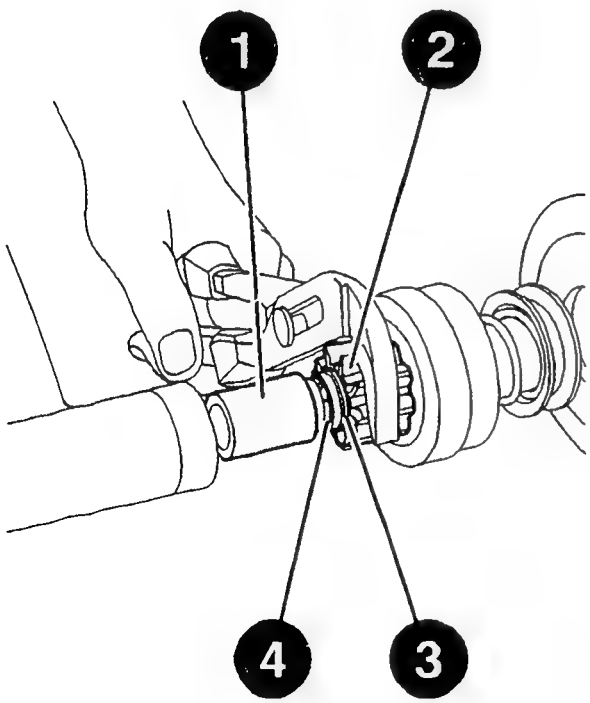
Gear-unit assembly

Slacken off clamping support.
Slip fitting sleeve (1) onto armature shaft.

Fitting sleeve for snap ring for armature shaft diameter 14.2 mm: 0 986 617 114

Continue: IV01/1 Fig.: III28/2

KMS00280



STARTING-MOTOR ASSEMBLY

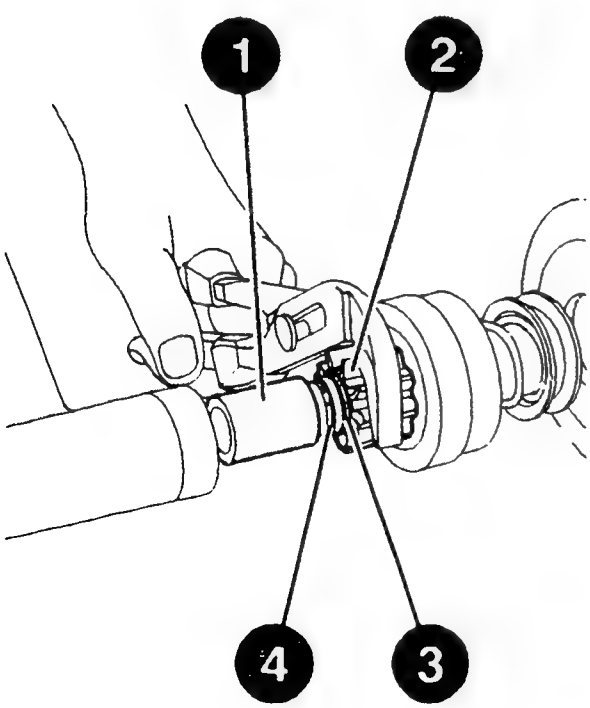
Gear-unit assembly

Use gripping pliers to set pinion (2) such that stop ring (3) is pressed against snap ring (4). Tap firmly with plastic-headed hammer on fitting sleeve to engage snap ring beneath stop ring.

Gripping pliers: comm. avail.

Continue: III24/1 Fig.: IV01/2

KMS00280



STARTING-MOTOR ASSEMBLY

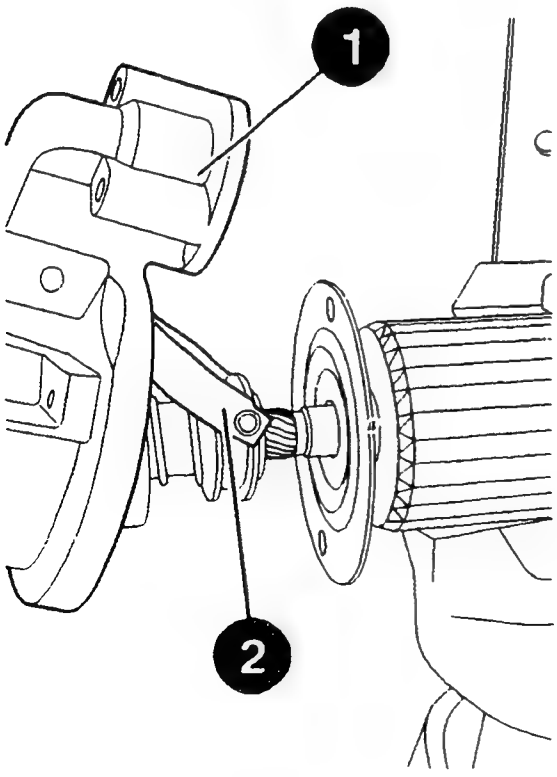
Drive-end bearing assembly
(Grey cast iron - closed type)

Clamp armature in clamping support. Insert engaging lever (2) in driver at gear unit and mount drive-end bearing (1).

Clamping support: 0 986 619 362

Continue: IV03/1 Fig.: IV02/2

KMS00260



STARTING-MOTOR ASSEMBLY

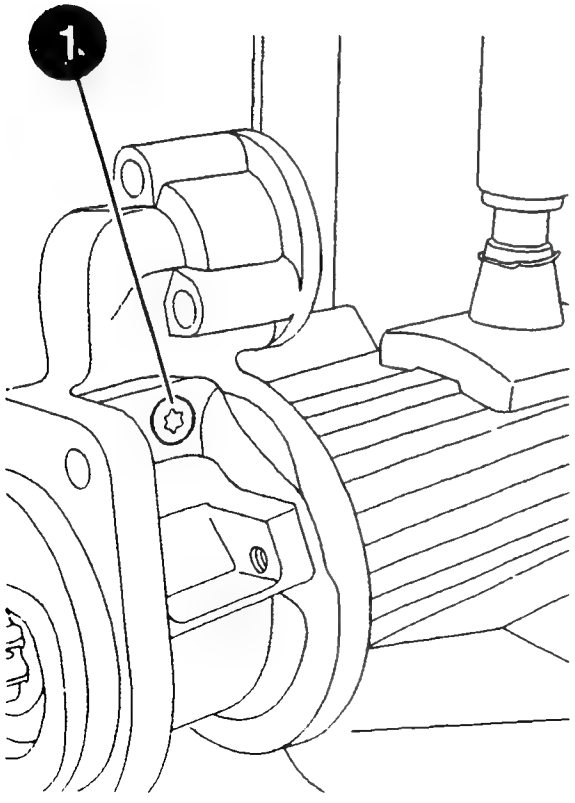
Drive-end bearing assembly
(Grey cast iron - closed type)

Install bearing pin (1) of engaging lever in drive-end bearing.
Use torque wrench.

Torque wrench:	comm. avail.
Torx T40 bit:	comm. avail.
Tightening torque (hexagon nut):	9,0...11,0 Nm

Continue: IV04/1 Fig.: IV03/2

KMS00259



STARTING-MOTOR ASSEMBLY

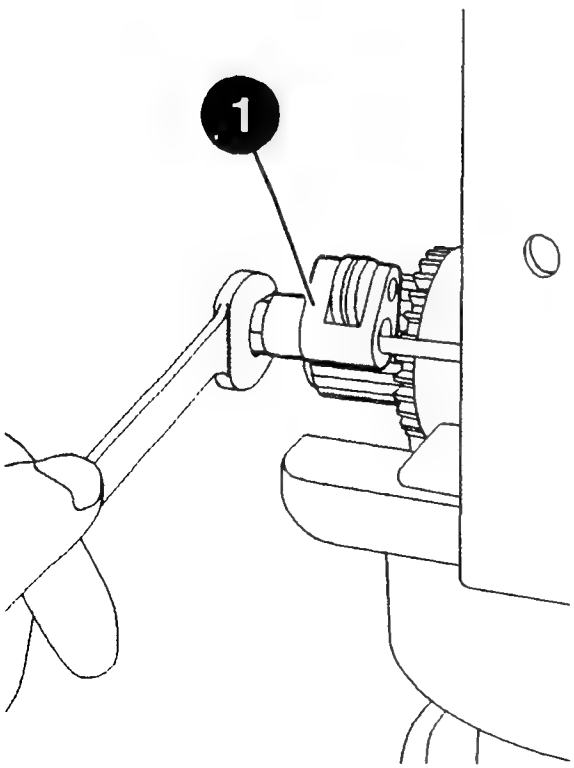
Drive-end bearing assembly
(Grey cast iron - closed type)

Use fitting and extraction tool (1) to secure both stay bolts in drive-end bearing.

Stay bolt fitting and extraction tool: comm. avail.

Continue: III24/1 Fig.: IV04/2

KMS00258



STARTING-MOTOR ASSEMBLY

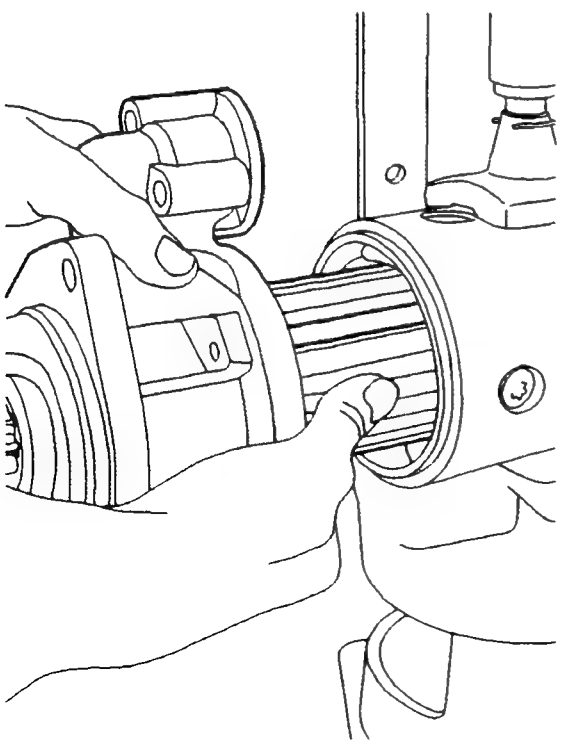
Assembly of drive-end bearing with armature
(Grey cast iron - closed type)

Clamp stator frame in clamping support. Insert armature complete with drive-end bearing in stator frame. Pay attention to mark.
ATTENTION: Make sure stay bolts do not damage excitation windings.

Clamping support: 0 986 619 362

Continue: III24/1 Fig.: IV05/2

KMS00257



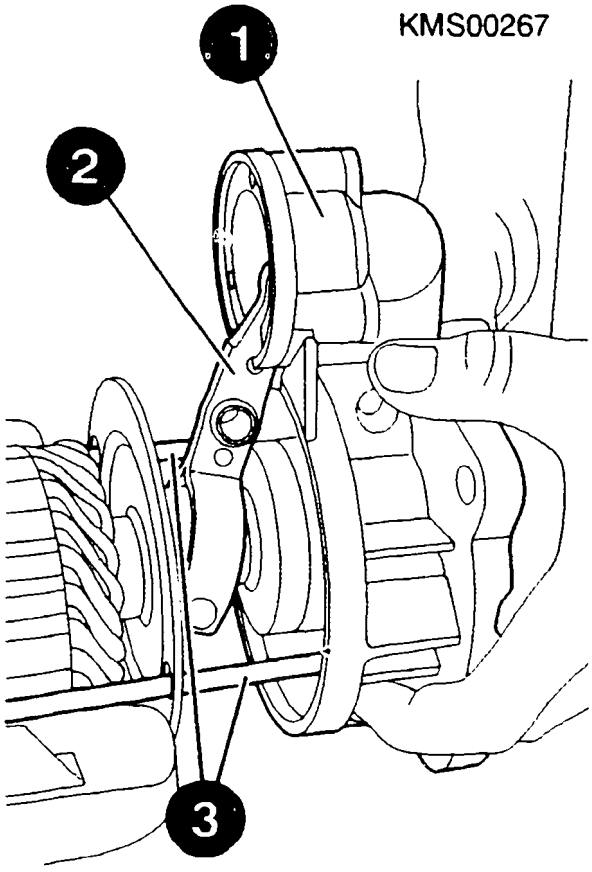
STARTING-MOTOR ASSEMBLY

Drive-end bearing assembly (Die-cast aluminum - open type)

Clamp armature in clamping support.
Use fitting and extraction tool to secure both stay bolts (3) in drive-end bearing.
Insert engaging lever (2) in driver at gear unit and mount drive-end bearing (1).

Clamping support:	0 986 619 362
Stay bolt fitting and extraction tool:	comm. avail.

Continue: IV07/1 Fig.: IV06/2



STARTING-MOTOR ASSEMBLY

Drive-end bearing assembly
(Die-cast aluminum - open type)

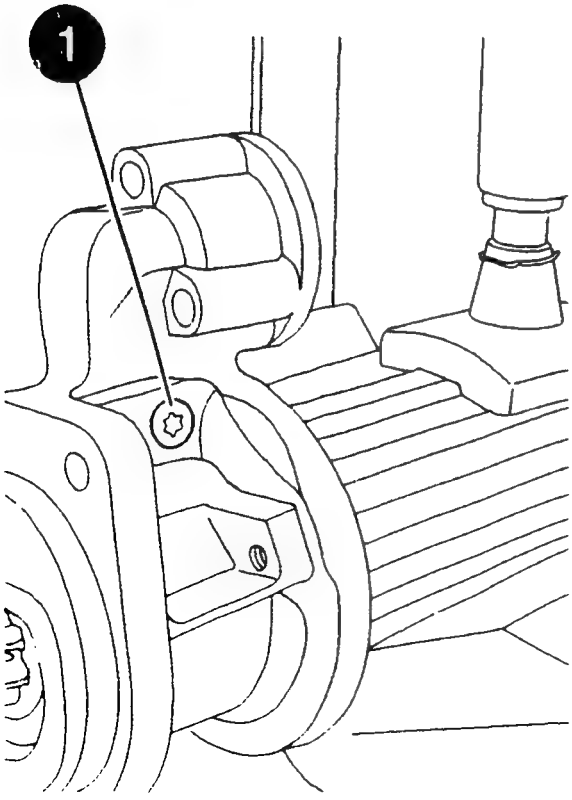
Install bearing pin (1) of engaging lever in drive-end bearing.
Use torque wrench.

Torque wrench:	comm. avail.
Torx T40 bit:	comm. avail.

Tightening torque (hexagon nut):	9,0...11,0 Nm

Continue: IV08/1 Fig.: IV07/2

KMS00259



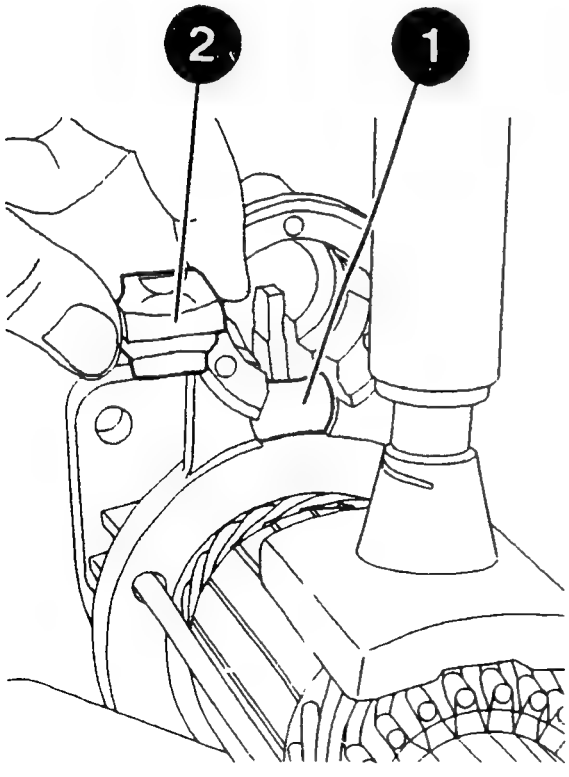
STARTING-MOTOR ASSEMBLY

Drive-end bearing assembly
(Die-cast aluminum - open type)

Insert support plate (1) first, then gasket (2).

Continue: III24/1 Fig.: IV08/2

KMS00281



STARTING-MOTOR ASSEMBLY

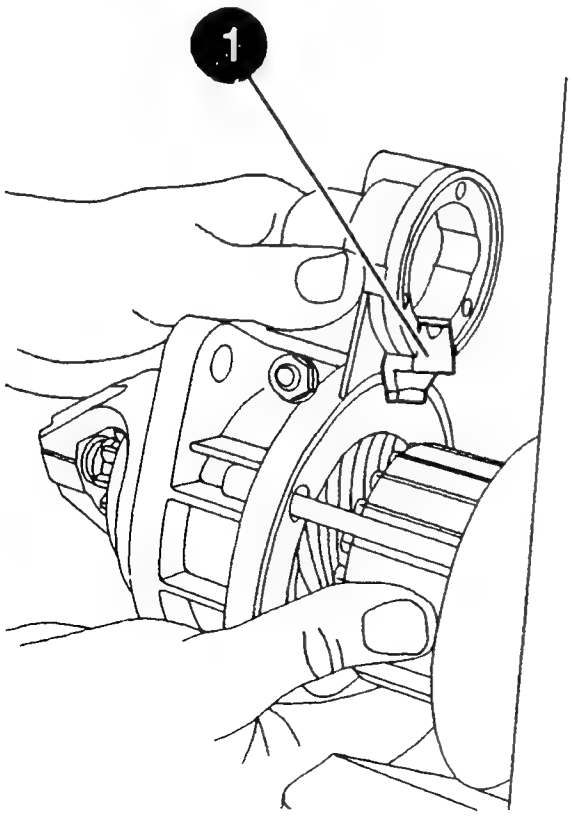
Assembly of drive-end bearing with armature
(Die-cast aluminum - open type)

Clamp stator frame in clamping support.
Insert armature complete with drive-end bearing in stator frame.
Make sure gasket (1) is properly seated in stator frame.
ATTENTION: Make sure stay bolts do not damage excitation windings.

Clamping support: 0 986 619 362

Continue: III24/1 Fig.: IV09/2

KMS00266



STARTING-MOTOR ASSEMBLY

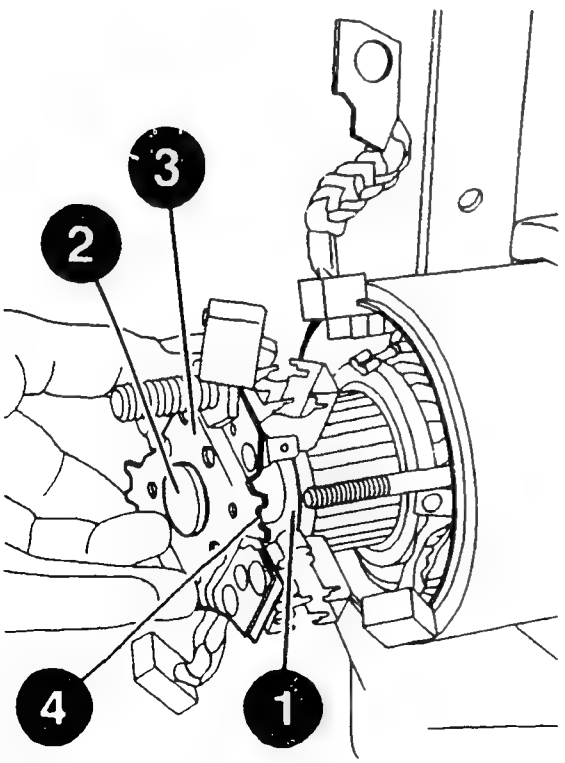
Brush-holder assembly

Slip thrust washer (1) and centering sleeve (2) onto armature shaft.
Slip brush holder (3) over centering sleeve.
Pay attention to locking element (4).

Centering sleeve for brush holder: Own make

Continue: III24/1 Fig.: IV10/2

KMS00283



STARTING-MOTOR ASSEMBLY

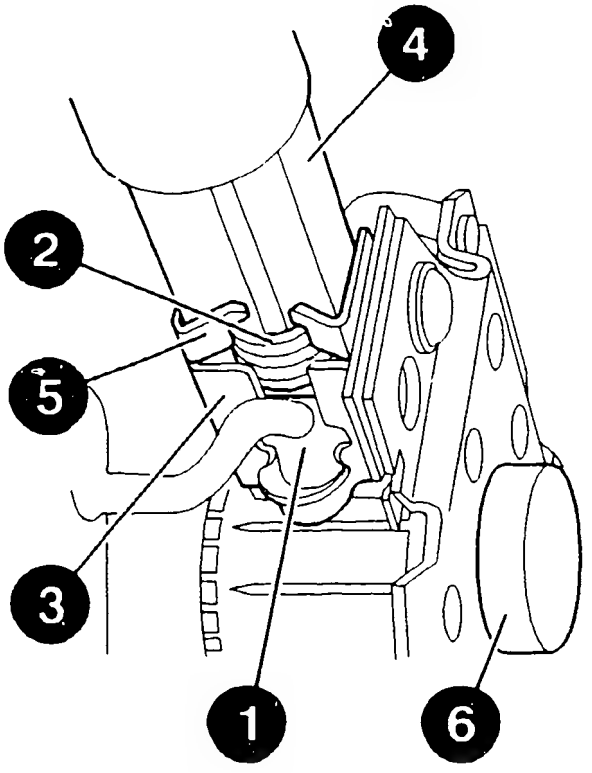
Carbon-brush assembly

Insert carbon brushes (1) and helical compression springs (2) in tubular brush holder (3) and press down using assembly tool (4).

Carbon-brush assembly tool
Depending on type: 0 986 617 115
0 986 617 116
0 986 617 117

Continue: IV12/1 Fig.: IV11/2

KMS00234



STARTING-MOTOR ASSEMBLY

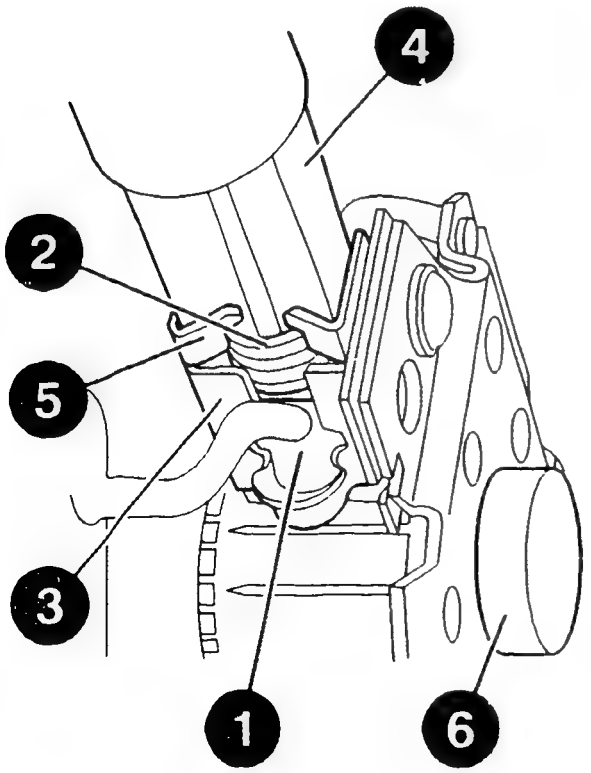
Carbon-brush assembly

Use flat-nosed pliers to bend round retaining lugs (5) in line with shape of assembly tool.
Removing centering sleeve (6).
Pay attention to freedom of movement of carbon brushes.
Press stranded wires of carbon brushes outwards to prevent contact with commutator.

Flat-nosed pliers: comm. avail.

Continue: III24/1 Fig.: IV12/2

KMS00234



STARTING-MOTOR ASSEMBLY

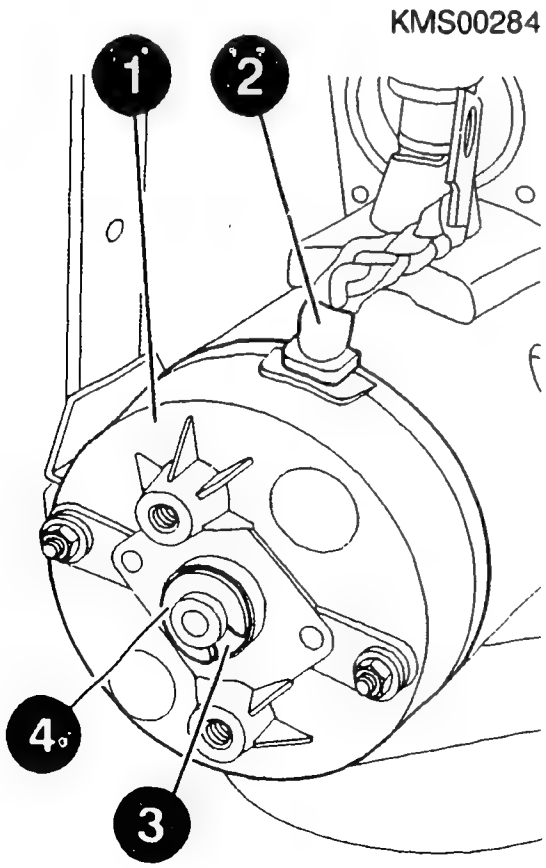
Commutator end shield assembly

Attach commutator end shield (1).
Use torque wrench.
Ensure proper attachment of rubber sleeve (2) at connection of excitation winding.
Slip shim (3) onto armature shaft and insert locating washer (4) in annular groove. Only one shim > 0.5 mm may be used.

Torque wrench: comm. avail.

Tightening torque: 9,1...12,2 Nm

Continue: III24/2 Fig.: IV13/2



STARTING-MOTOR ASSEMBLY

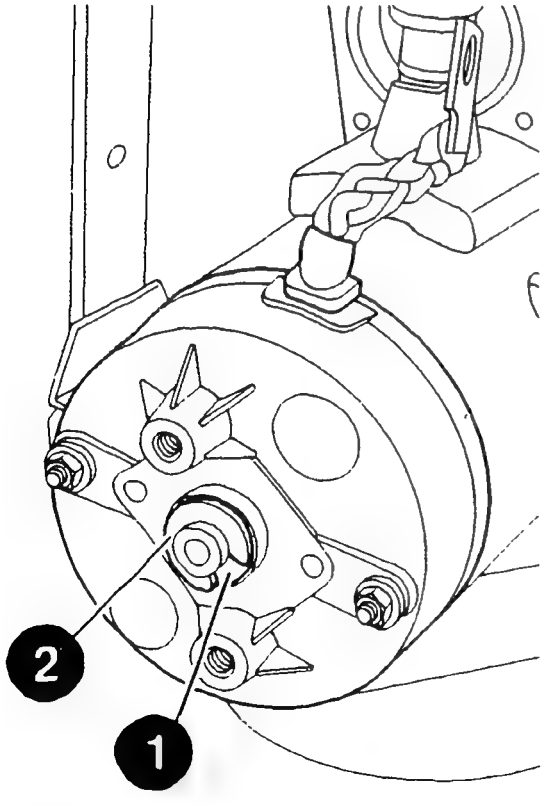
Checking and adjusting armature axial clearance

Use shim (1) to adjust armature axial clearance. Only use shim of appropriate thickness (> 0.5 mm). If several shims are needed, the thickest shim (> 0.5 mm) must be in contact with the locating washer (2).
Check freedom of movement of armature.

Armature axial play: 0,1...0,6 mm

Continue: III24/2 Fig.: IV14/2

KMS00285



STARTING-MOTOR ASSEMBLY

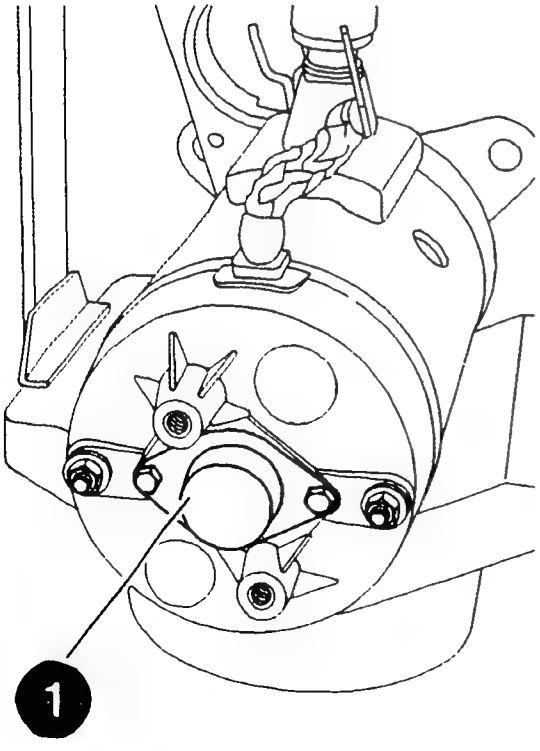
Bearing end plate assembly

Fill 1/3 of bearing end plate with grease.
Slip new seal over collar of commutator end shield and attach bearing end plate (1). Use torque wrench.

Torque wrench:	comm. avail.
Grease VS 10832 Ft:	5 932 240 000
Tightening torque:	4,5...6,0 Nm

Continue: III24/2 Fig.: IV15/2

KMS00286



STARTING-MOTOR ASSEMBLY

Testing armature braking torque

Take set value for armature braking torque for type of starting motor concerned from table.

0 001 362 ...:	0,45...0,75 Nm
0 001 363 ...:	0,45...0,75 Nm
0 001 366 ...:	0,45...0,75 Nm
0 001 364 ...:	0,50...1,20 Nm
0 001 367 ...:	0,50...1,20 Nm
0 001 368 ...:	0,50...1,20 Nm
0 001 369 ...:	0,50...1,20 Nm

Continue: IV17/1

STARTING-MOTOR ASSEMBLY

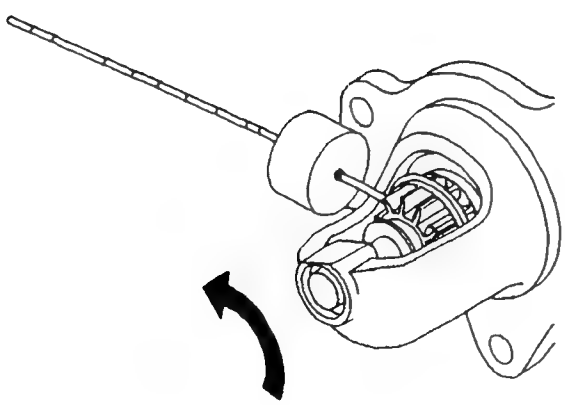
Testing armature braking torque
(set value: 0,45...0,75 Nm)

Attach torquemeter to pinion such that it is loaded in working direction (see arrow). Move torquemeter to horizontal position. Shift weight until pinion with armature starts to rotate.
Scale reading must be 4,5...7,5.
This corresponds to 0,45...0,75 Nm.

Torquemeter:	0 986 617 206
Armat. braking torque:	0,45...0,75 Nm

Continue: IV18/1 Fig.: IV17/2

KMS00287



STARTING-MOTOR ASSEMBLY

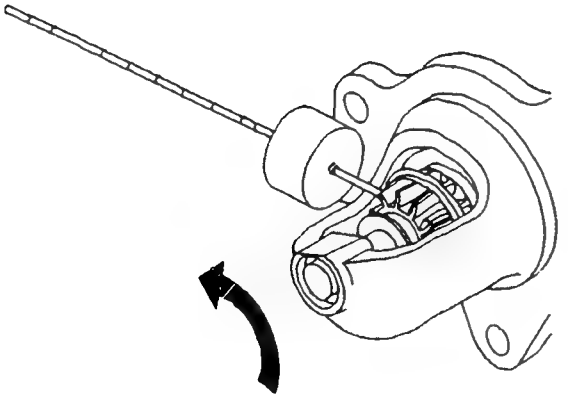
Testing armature braking torque
(set value: 0,50...1,20 Nm)

Attach torquemeter to pinion such that it is loaded in working direction (see arrow). Move torquemeter to horizontal position. Shift weight until pinion with armature starts to rotate.
Scale reading must be 5...8.
This corresponds to 0,50...0,80 Nm.

Torquemeter:	0 986 617 206
Armat. braking torque:	0,50...1,20 Nm

Continue: IV19/1 Fig.: IV18/2

KMS00287



STARTING-MOTOR ASSEMBLY

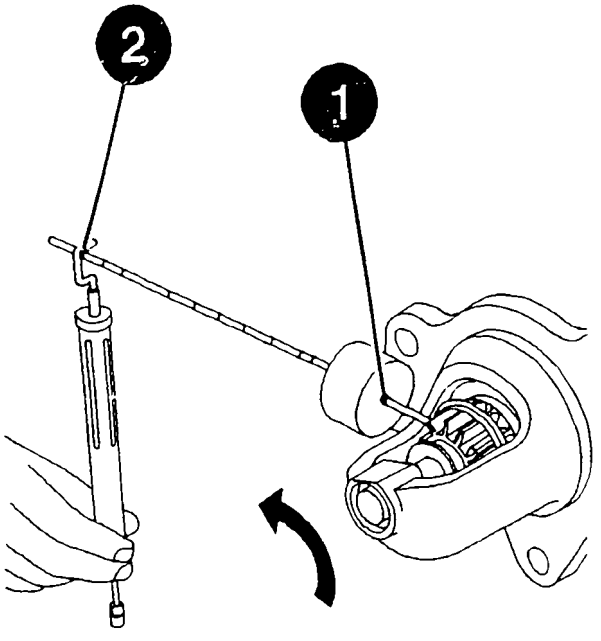
Testing armature braking torque
(set value: 0,50...1,20 Nm)

If the torque which can be applied with the torquemeter is not sufficient to overcome the armature braking torque, proceed as follows:
Shift weight to second mark 2.0 (1).
Position spring balance at last mark 8 (2).

Torquemeter:	0 986 617 206
Spring balance:	0 986 619 181

Continue: IV20/1 Fig.: IV19/2

KMS00242



STARTING-MOTOR ASSEMBLY

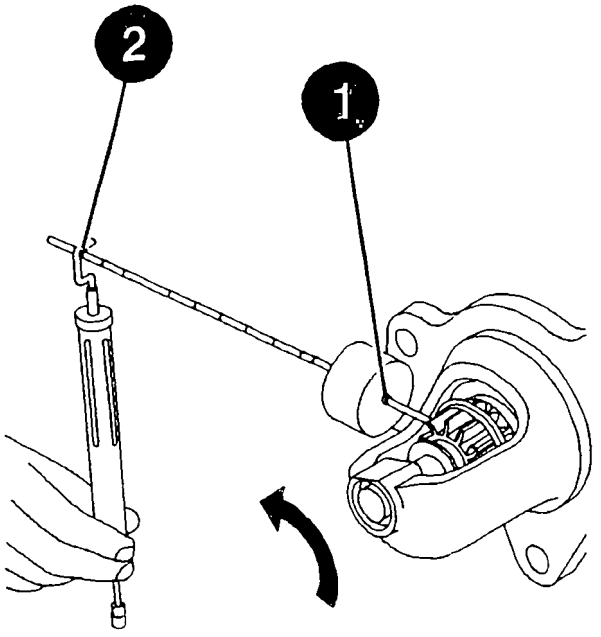
Testing armature braking torque
(set value: 0,50...1,20 Nm)

Pull on spring balance until pinion with armature starts to rotate.
Take spring balance scale reading.
Reading must be 0,21...0,35 kg, corresponding to tensile force of 2,00...3,40 N.
The armature braking torque is then within the required range. If this is not the case, check components and their assembly.

Armat. braking torque: 0,50...1,20 Nm

Continue: III24/2 Fig.: IV20/2

KMS00242



STARTING-MOTOR ASSEMBLY

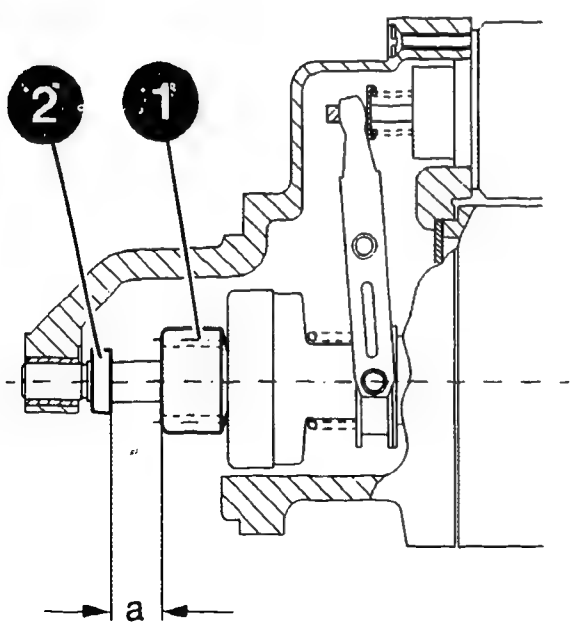
Testing total pinion travel

Measure meshing travel between pinion (1) (at rest) and stop ring (2).

Total pinion travel a
Depending on version: 13...17 mm
16...20 mm

Continue: III24/2 Fig.: IV21/2

KMS00288



STARTING-MOTOR ASSEMBLY

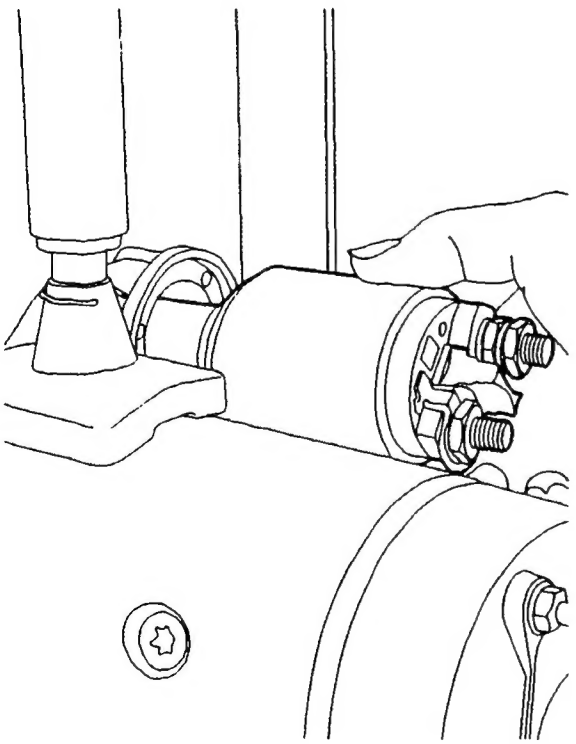
Solenoid-switch assembly

Press pinion against stop ring and position relay armature in engaging lever.
Slip on solenoid switch and attach to drive-end bearing.
Pay attention to marking.
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque:	4,5...6,0 Nm

Continue: IV23/1 Fig.: IV22/2

KMS00251



STARTING-MOTOR ASSEMBLY

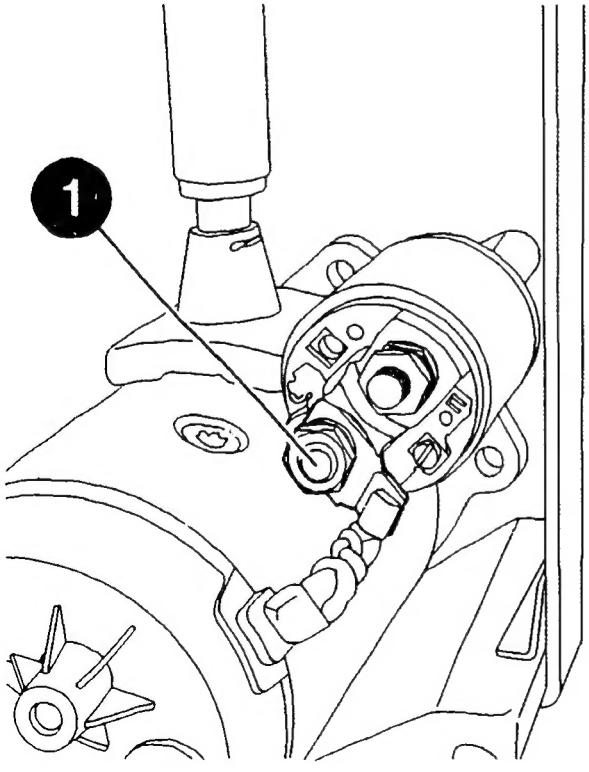
Solenoid-switch assembly

Attach connection of excitation winding (1) to solenoid switch.

Tightening torque term. 30/30-f
M10 Steel: 12...15 Nm
M10 Copper: 10...12 Nm

Continue: III24/2 Fig.: IV23/2

KMS00250



STARTING-MOTOR ASSEMBLY

Testing pull-in voltage

Following starting-motor assembly, check minimum pull-in voltage of solenoid switch on starting-motor test bench.
Connect up starting motor in line with test-bench operating instructions.

The starting motor must be clamped such that the gap between the starting-motor meshing pinion and the toothed segment of the test bench is 1 mm.

Continue: IV24/2

STARTING-MOTOR ASSEMBLY

In tooth-on-tooth position, pull-in voltage must be within stated range.
If not, check whether starting motor has been properly repaired and assembled.
Solenoid switch and overrunning-clutch drive must coincide with types given in service parts list for respective starting-motor version.

Pull-in voltage (measurement time <2 s)

12 V starting motor:	< 8 V
24 V starting motor:	15...18 V

Continue: III24/2

EDITORIAL NOTE

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Continue: IV25/2

EDITORIAL NOTE

Continue: I01/1